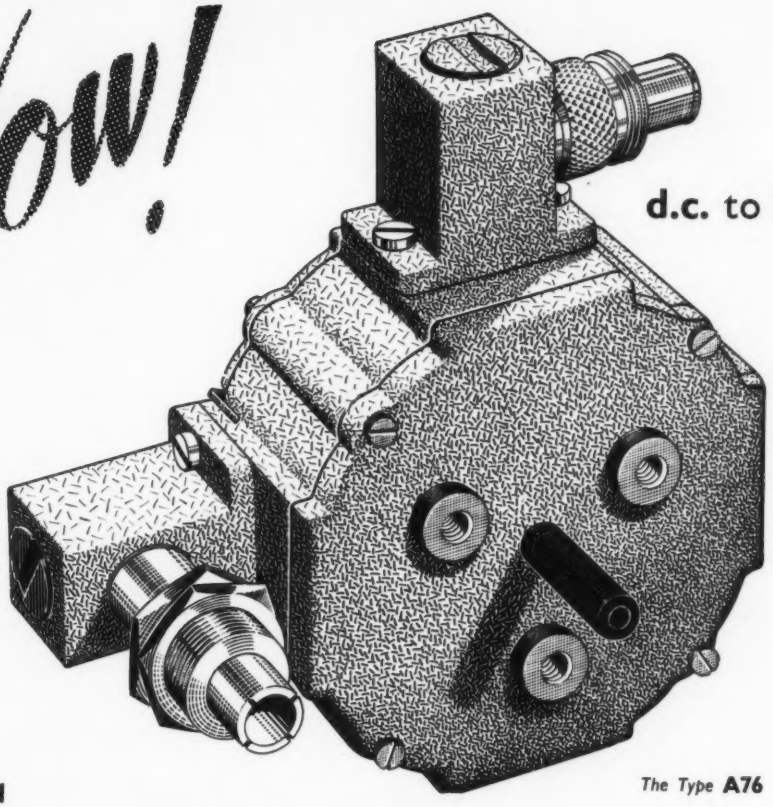
Circle 3 for further information

Now!

d.c. to V.H.F.



The Type **A76**

a range of WIDE BAND ATTENUATORS

by

Advance

-to be sure!

FOUR MODELS

★ **TYPE A75** Range 99 dB in 1 dB steps.
Input and Output impedance 75 ohms.
Price **£19** nett in U.K.

★ **TYPE A76** Range 90 dB in 10 dB steps.
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To our comprehensive range of attenuators, we announce the addition of four new models.
These attenuators employ resistive ladder network and provide accurate attenuation over a wide frequency band.
They are small compact units ideal for building into customers' own equipment or for bench use in the laboratory.
Full details are given in leaflet No. M57 gladly sent on request.

GD68/C **Advance** COMPONENTS LIMITED · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TELEPHONE: HAINAULT 4444

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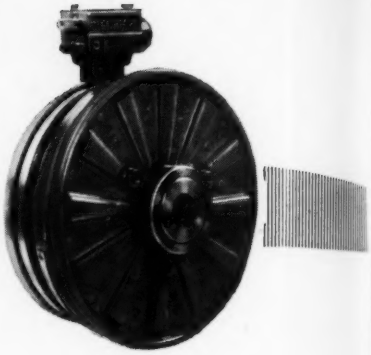
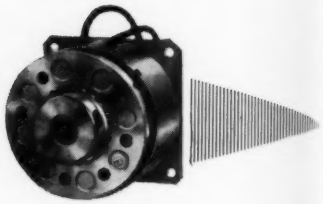
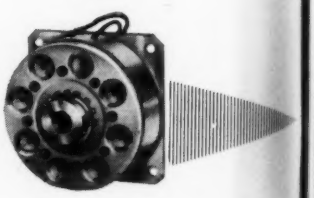






. . . for those demanding the BEST in machine control

Warner Electric Brakes & Clutches are stepping up production, shrinking costs, reducing operator fatigue and saving time.

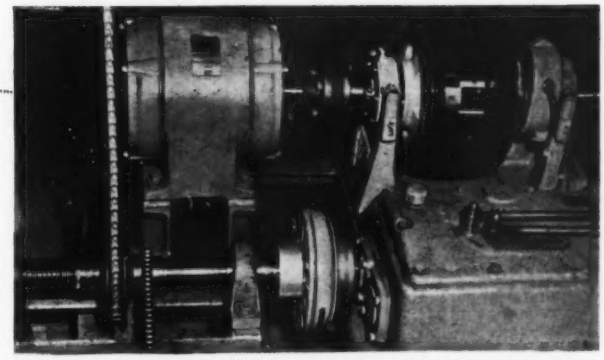
They give lightning-fast, yet smooth cushioned stops and starts; cycle, reverse and index at the touch of a button and are remarkably simple and foolproof in use. Operation is positive and easily controlled to produce the exact torque required.

Warner units occupy the minimum of shaft length, can be fitted to existing machines and enable new machines to be built smaller, faster and easier to operate. Automatic take-up for wear completely eliminates the need for adjustment.

Our Application Engineering Division is ready to advise at the design stage of new developments or on the conversion of existing machinery. Take action NOW.

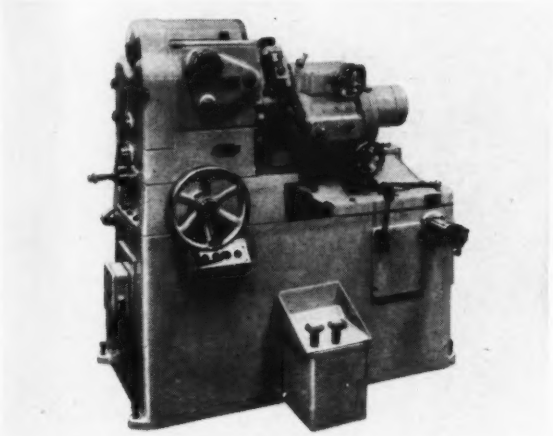
THE BRAKES AND CLUTCHES THAT STOP AT NOTHING

The more exacting the operation the more the need for WARNER ELECTRIC BRAKES & CLUTCHES



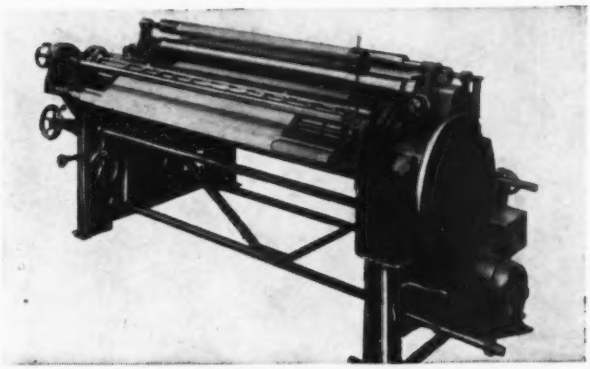
Fully automatic re-winding machine showing a Warner 825 Clutch Coupling incorporated in the main drive.

The General Engineering Company (Radcliffe) Ltd. Radcliffe.



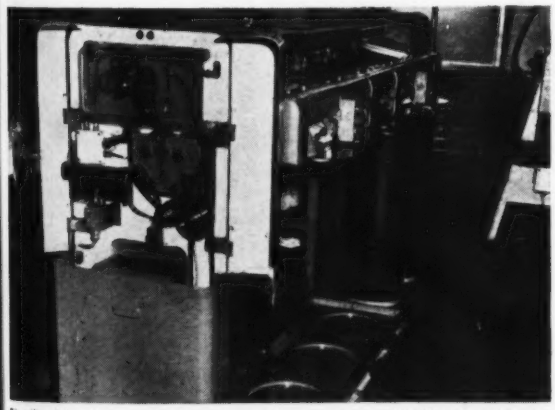
This Harry F. Atkins two spindle automatic Cam Milling Machine incorporates Warner S.F. 250 clutches to actuate an indexing drum mounted with two cutters which must be presented successively to the work and precisely positioned.

The Elgar Machine Co. Ltd. of London.



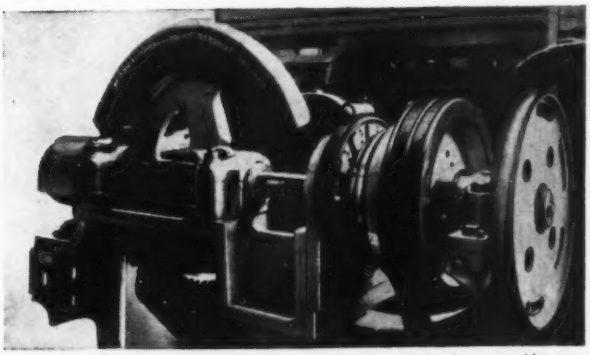
Toilet Roll Rolling and Slitting Machine. Warner 825 Clutch fitted to main drive gives ideal slow smooth starting characteristics for the operations involved.

T. H. Dixon & Co. Ltd. of Letchworth



Bi-coil and draw frame on textile equipment incorporating two S.F. 400 Warner Clutches.

Tweedales & Smalley Ltd. Rochdale.



A Warner 1000 Clutch in the main drive of this heavy matting loom provides pre-positioned stopping and rapid starting with safety factors hitherto unknown for this class of loom.

Wilson & Longbottom Ltd. of Barnsley.

Warner Electric Brakes & Clutches are manufactured in Great Britain under licence by:

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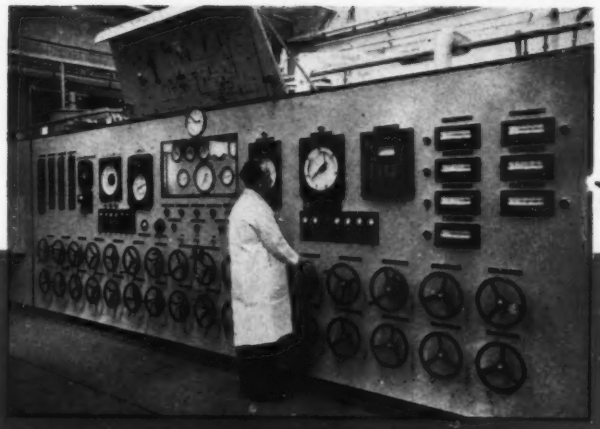

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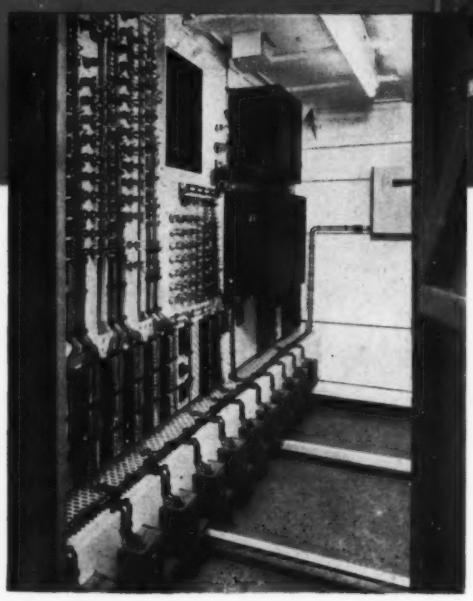
2. Final inspection before despatch from our factory at Colnbrook.



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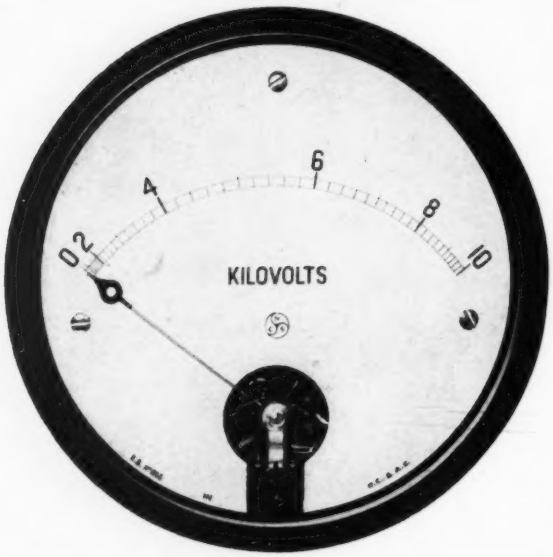

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Circle 9 for further information

For protection
against flame-failure

FLAME-FAILURE & IGNITION CONTROLLERS TYPES 700 & 701

*
For gas or oil-fired systems
*
Completely reliable
*
Extremely versatile
*

These high-quality Controllers eliminate the dangers arising from flame-failure, and are effective in almost all types of gas or oil-fired furnaces. They employ an infra-red-sensitive photo-cell to 'see' the flame in furnaces, which discriminates between flame and furnace-radiation. The photo-cell reacts instantly to flame-failure and, should this occur, the fuel supply is immediately shut off by an electronic control unit.

Two Controllers are available. The Type 700 is semi-automatic (with provision for automatic purge cycle) and the Type 701 is a fully-automatic relight unit

Other Controllers operating on flame-conductivity or flame-rectification, and complete installations, are also available.

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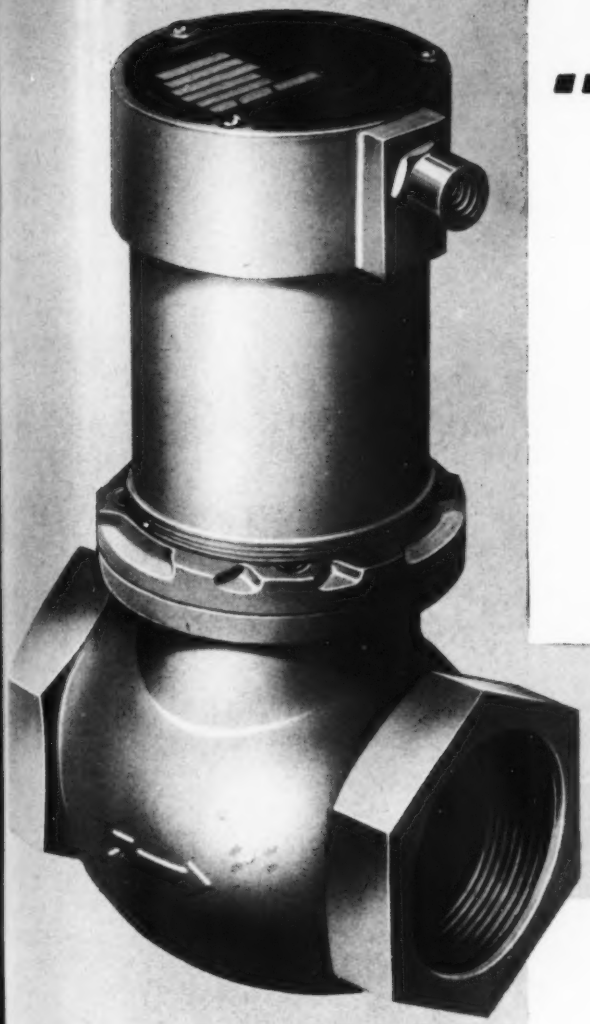

...and to complete your installation

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One of a range of highly-efficient solenoid valves, the LPG gives a completely tight shut-off at low pressures. It is particularly suitable for use on low-pressure town gas installations when a positive shut-off is required.

ETHER also offer valves incorporating a manual-reset feature and valves for use with all types of fuel oil, bottled gases, air and many fluids.

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COMBUSTION SAFEGUARD AND SOLENOID VALVE DIVISION

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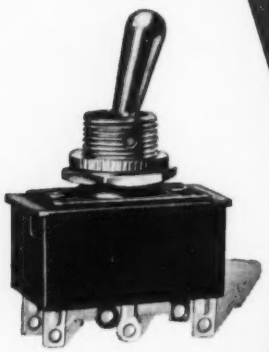
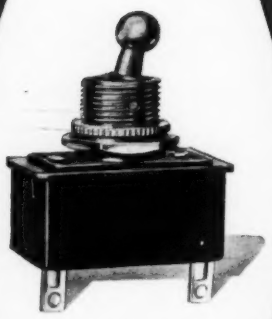
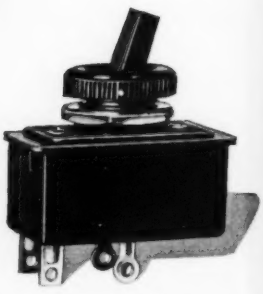
For Instrument and Electronic Applications



✲ Cat. No. 81058-BT Double Pole Double Throw 2 Position Lever Type Back Connecting Lugs



Cat. No. 81046 Single Pole Single Throw. 2 Position Lever Type. Back Connecting Lugs



Cat. No. 81055-B-BP Double Pole Single Throw 2 Position Insulated Lever Type. Back Connecting Lugs

The exacting conditions of service demanded by modern techniques in electronic equipment and instrument development are fully matched by this new range of ARROW bakelite enclosed switches.

Their main characteristic is the maintenance of low contact resistance after considerable life.

Circuits available S.P.S.T., S.P.D.T., D.P.S.T., D.P.D.T

** BIASED ACTION SUPPLIED FOR ALL CIRCUITS.*

Maximum rating 3 amps at 250V AC/DC.

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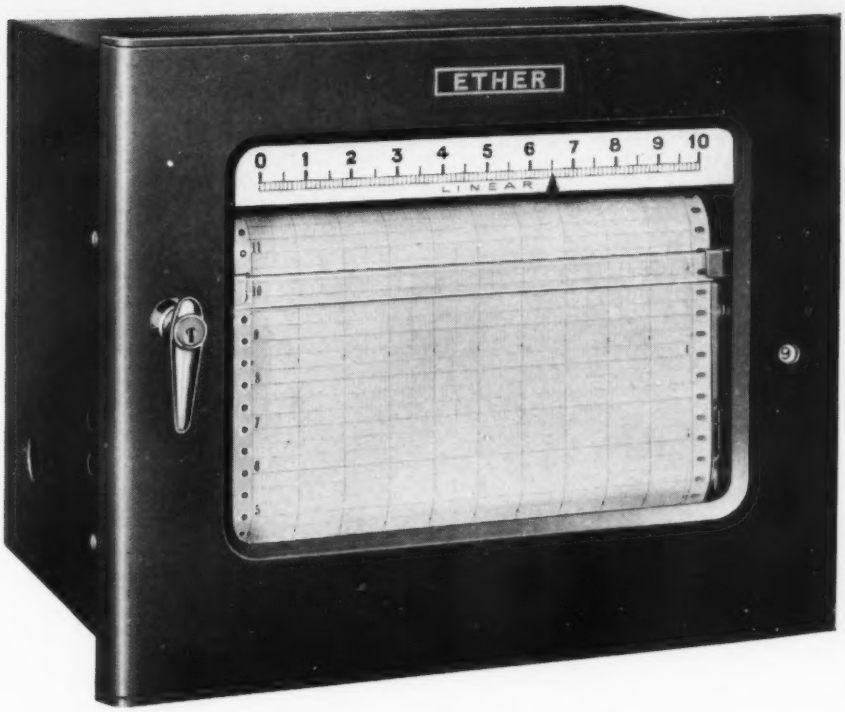
high standards of performance at infinitely lower cost!



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* *Full-scale balancing pen carriage*
(with speeds of 2, 5 or 13 seconds)
* *Models available to record from one to eighteen independent points*

These new ETHER instruments combine a remarkably high standard of performance with simplicity in operation, and require a minimum amount of maintenance. Models are available which measure, indicate, control and give a permanent record of temperature, using thermo-couples, resistance-bulbs or radiation-tubes. Speed, strain and any other variable that can be resolved into an electrical signal can also be recorded. Write now for comprehensive technical data!

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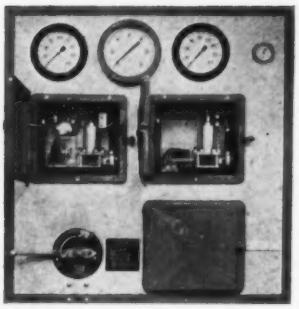

The control panel housing the pressure controls manual/automatic switch lever, pressure, temperature and draught gauges.

for
Water Tube boilers
Shell boilers
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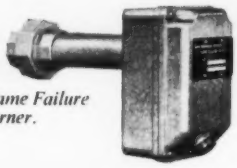
Industrial processes
Heat exchangers, thermal and nuclear.
The John Thompson La Mont auxiliary boilers as supplied to the Alfred Holt shipping line are fitted with automatic controls by John Thompson Instrument Co. Pressure controls, high pressure cut-outs, flame failure and air flow controls are linked with multiple safety features to give a compact reliable system.



A John Thompson Flame Failure unit fitted to the burner.

A section of the remote control, push-button unit showing some of the timers, relays and contactors.

JOHN THOMPSON INSTRUMENTS

JOHN THOMPSON GROUP

JOHN THOMPSON INSTRUMENT CO LTD · WOLVERHAMPTON

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Wattless amplification of small d.c. voltages and currents of the type appearing in the output circuit of chemical and physical active or inactive transmitters.

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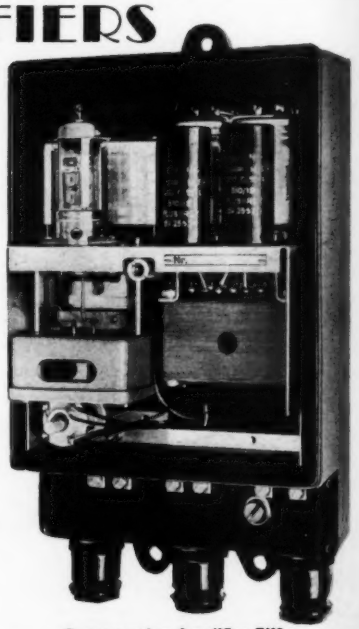

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Circle 13 for further information

Circle 14 for further information

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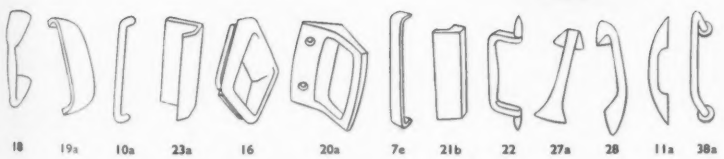

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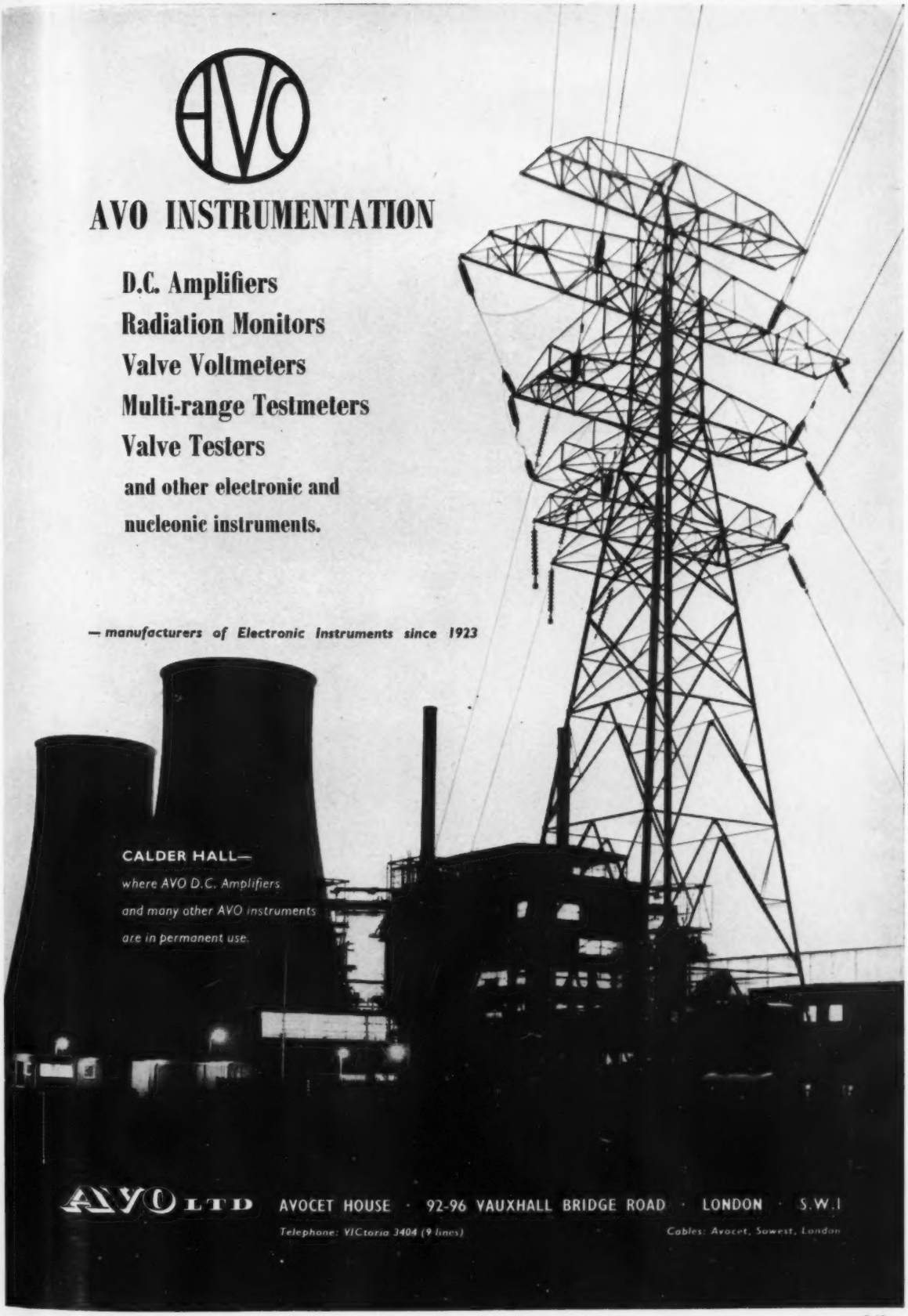

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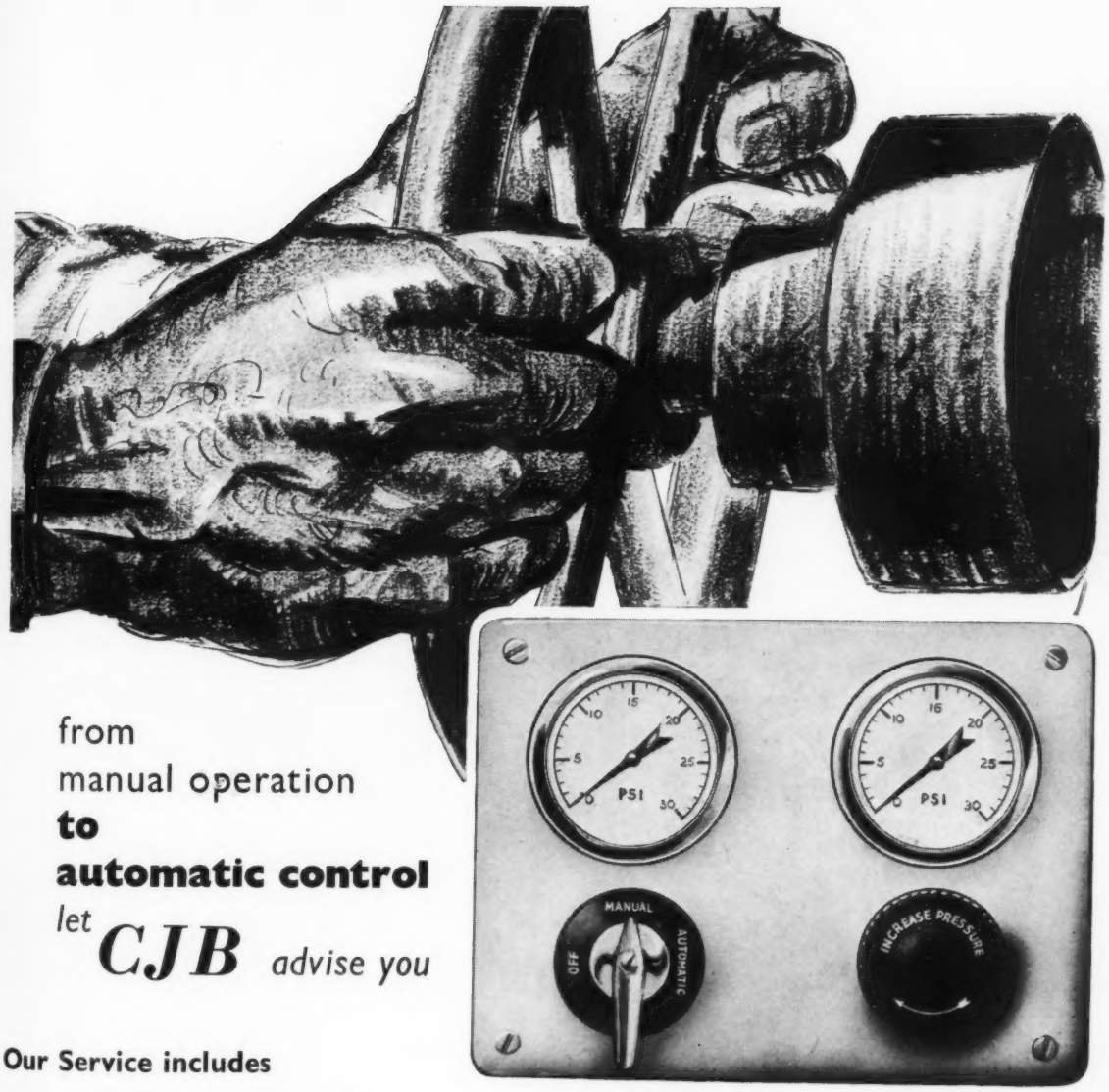

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Translated from the Russian

Instrument Construction
is the Russian monthly journal *Priborostroenie* in English translation from the January 1959 issue onwards.

The Russians describe their publication as a 'scientific, technical and production' journal. It covers industrial instruments and instrumentation, automatic control, and production engineering for precision work. The articles which it presents not only introduce new instruments and techniques, they also afford a valuable insight into current Russian practice.

Instrument Construction is being produced by the British Scientific Instrument Research Association for the Department of Scientific and Industrial Research as part of the D.S.I.R. translating programme designed to help meet the increasing demand for detailed, up-to-date information on Russian science and technology. Its original, *Priborostroenie*, is one of a number of Russian journals which have been proposed by D.S.I.R. for cover-to-cover translation through co-operating specialist organisations in Great Britain and in co-ordination with parallel activities in the U.S.A.

Priborostroenie is published in Moscow. Editor-in-chief: M. E. RAKOVSKII. Sub-editor: YU. I. SHENDLER.

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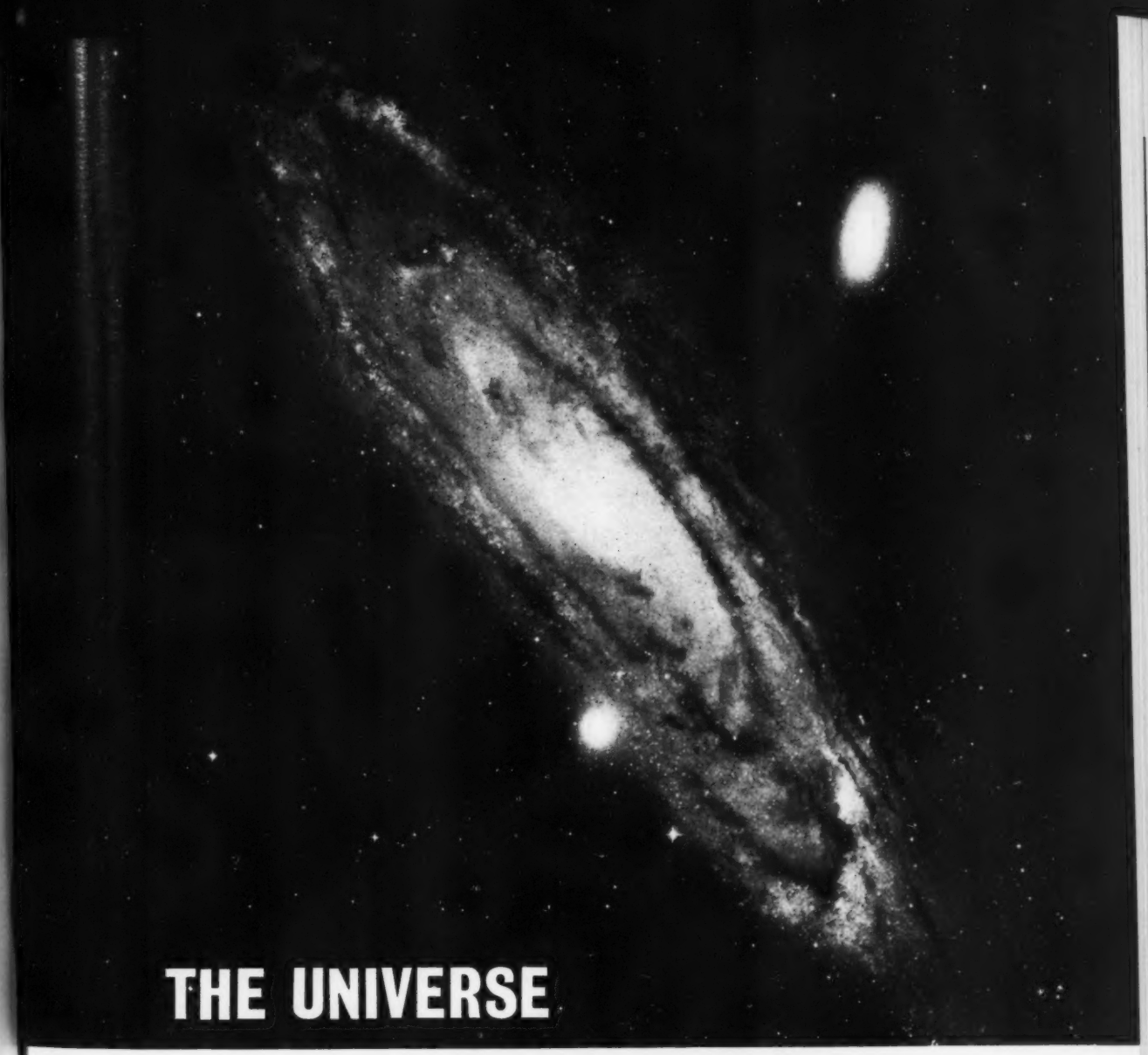

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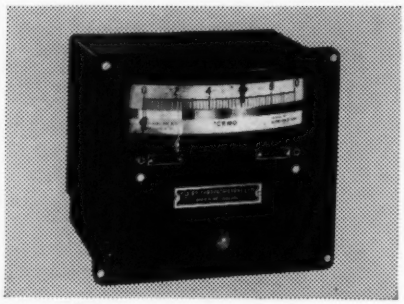

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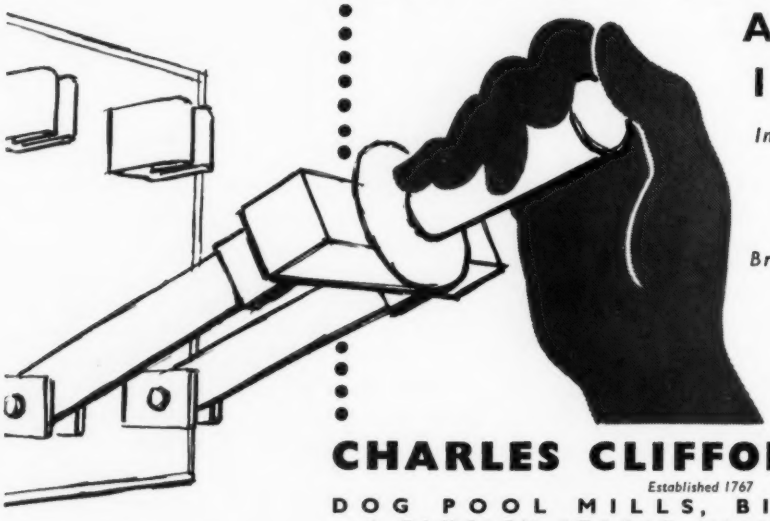

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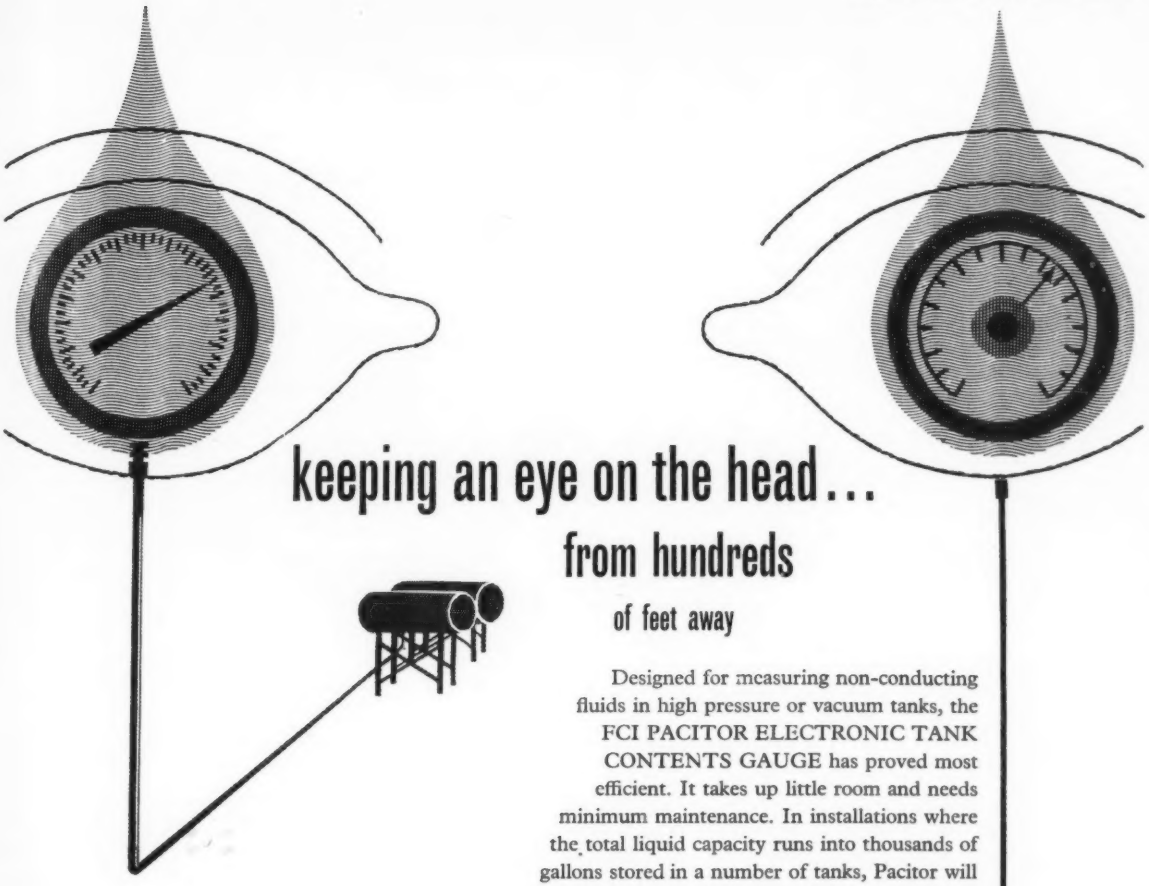

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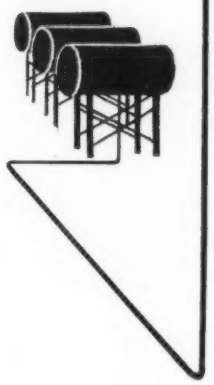

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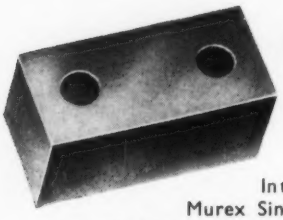

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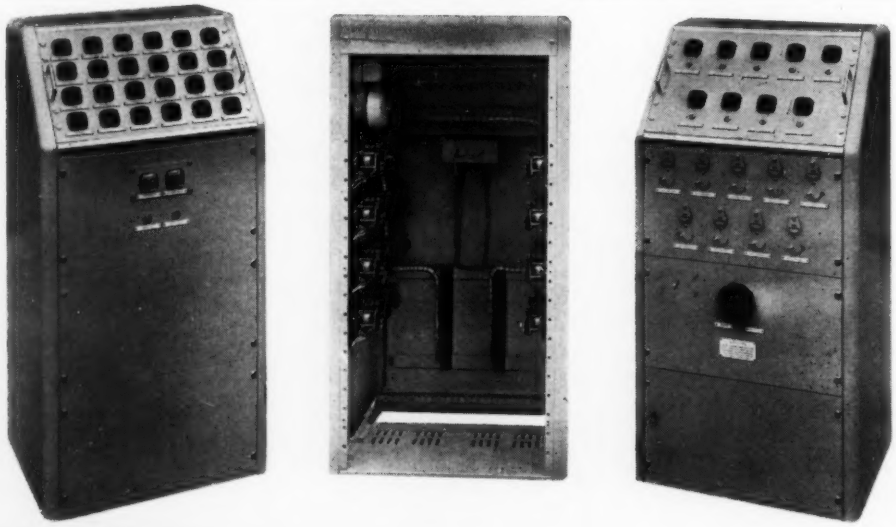

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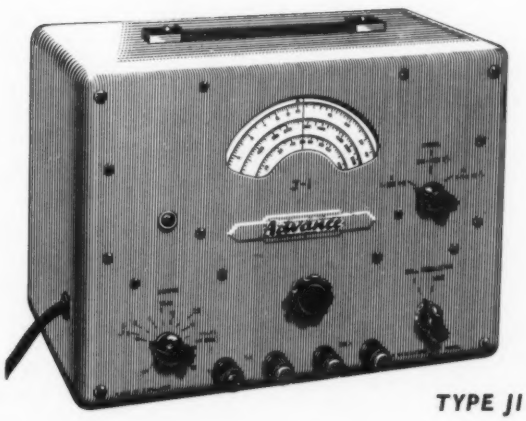

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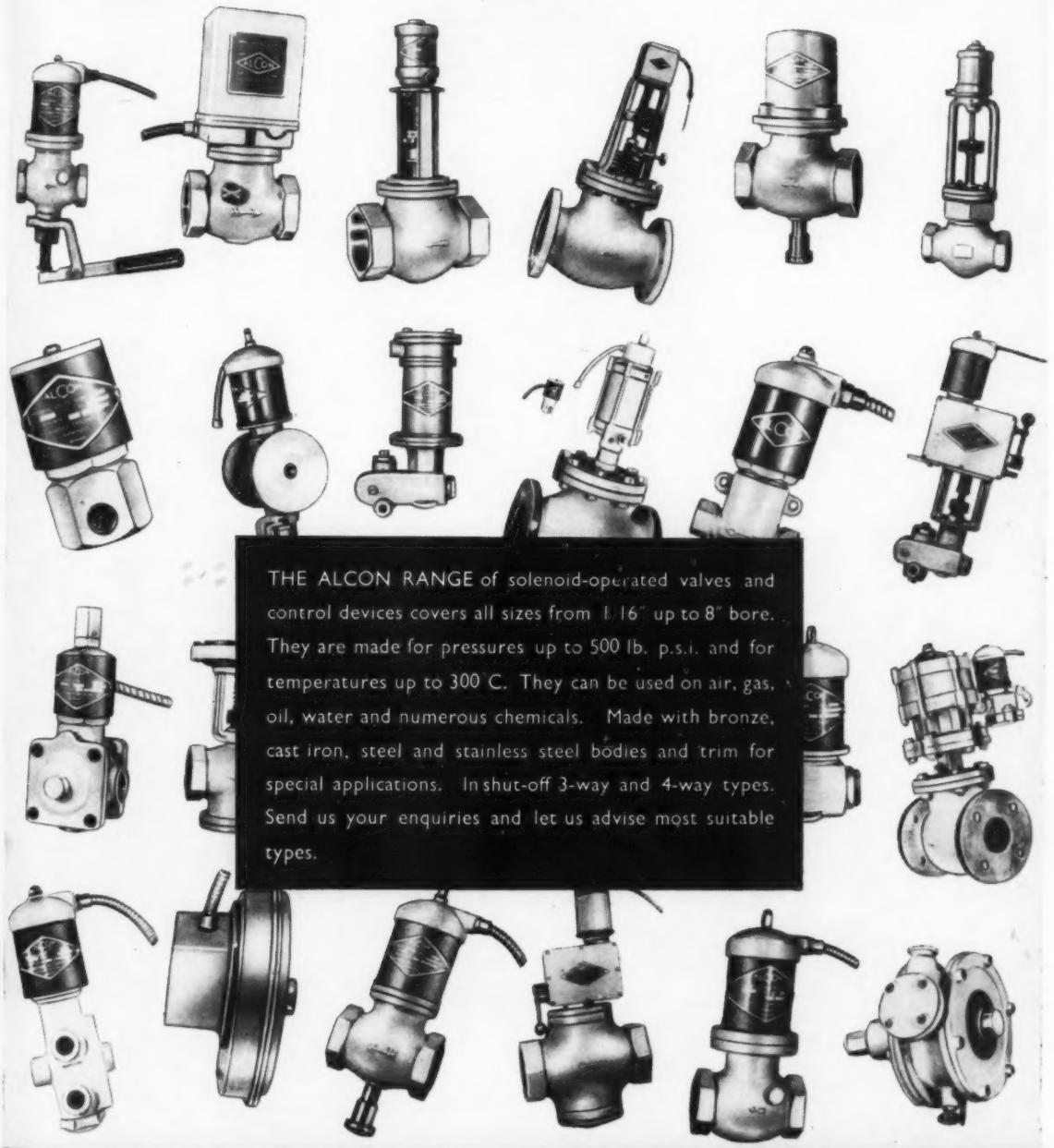

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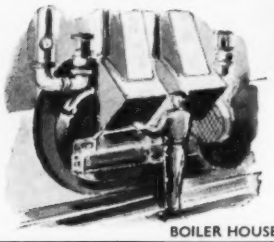

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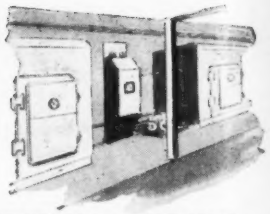

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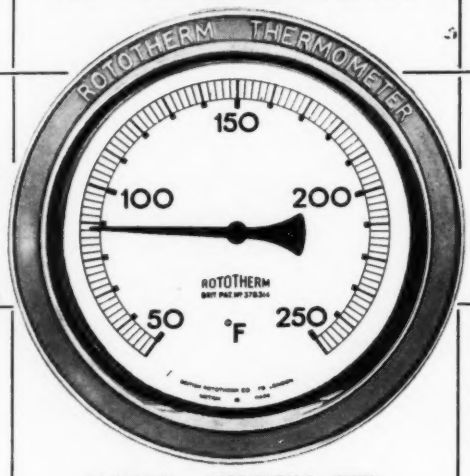

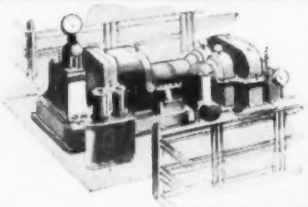

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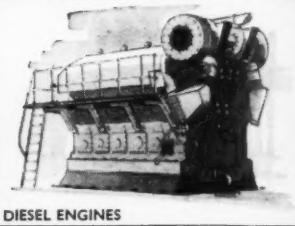

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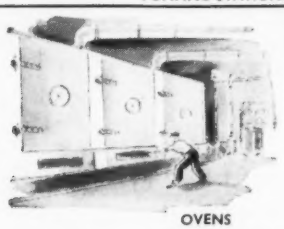

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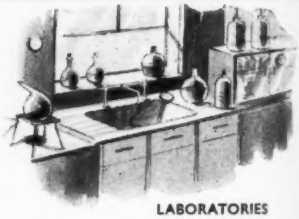

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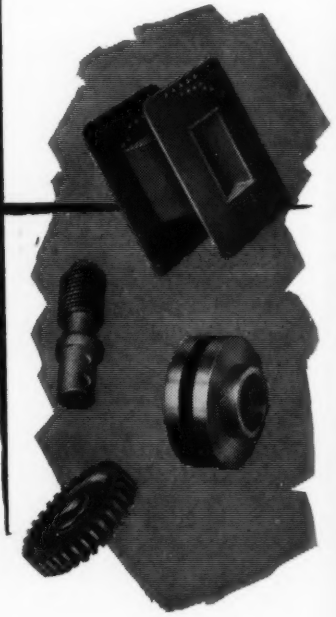

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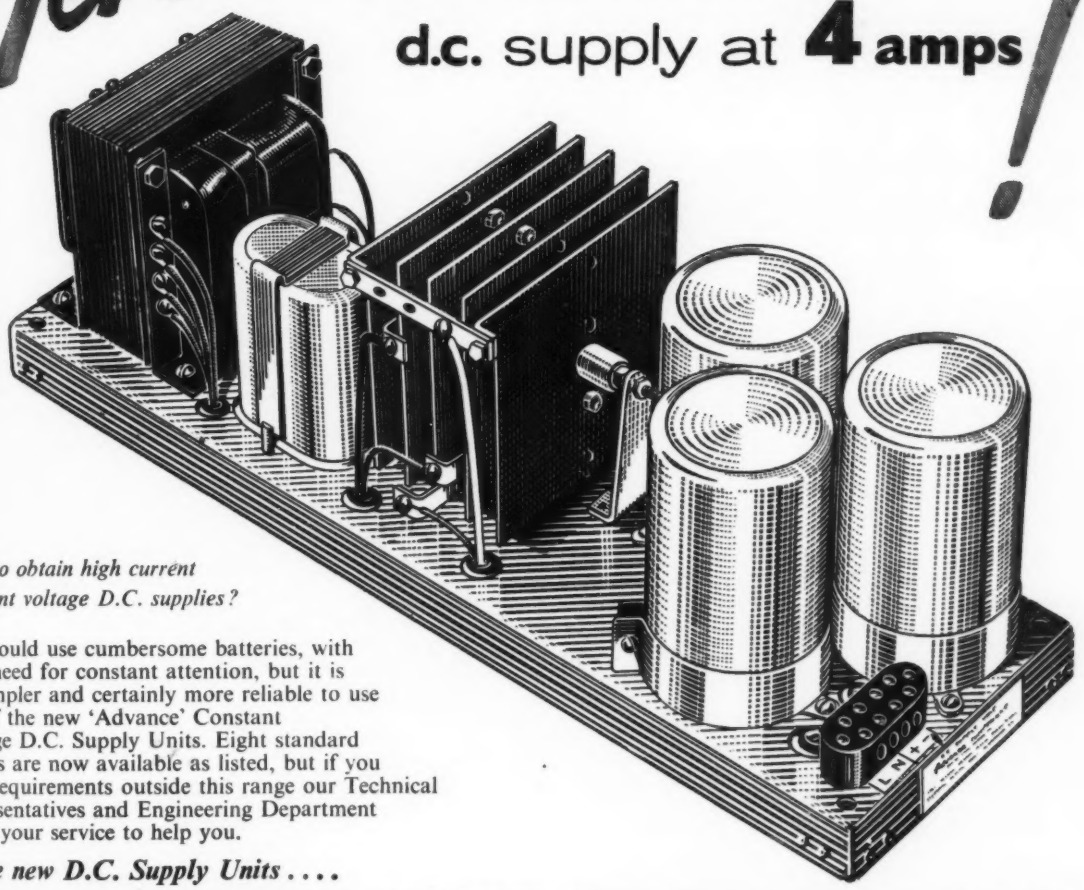

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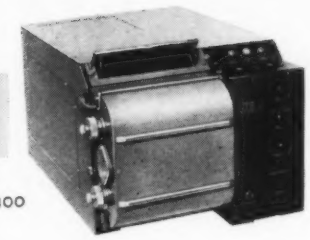

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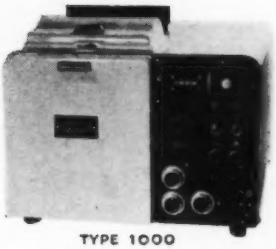

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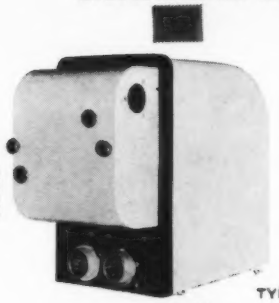

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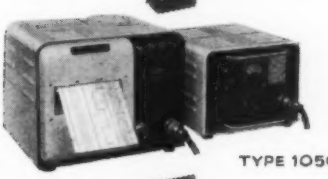
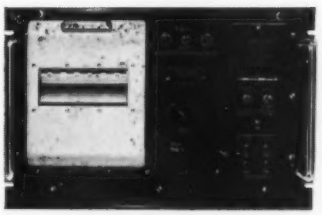


TYPE 1050



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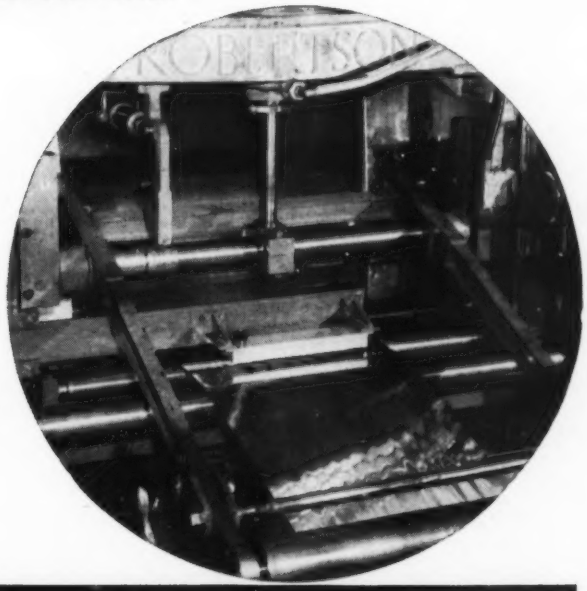

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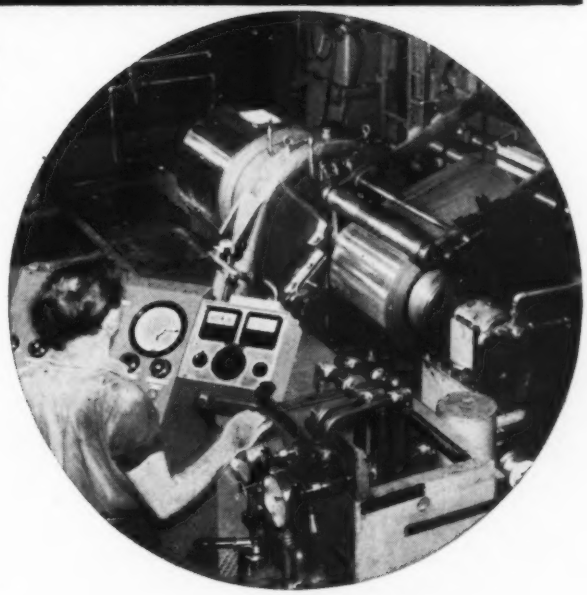

Baldwin Atomats are already boosting production and cutting costs in the paper, metal rolling, rubber and plastics industries. Highly successful applications also include the measuring of selenium on aluminium, coatings of paint and lacquers, density of wood chips, coatings of grit on abrasive papers and padding and resin impregnation in the textile industry. But the potential of Baldwin Atomat Nucleonic Gauges has hardly been tapped.
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INSTRUMENT DIVISION

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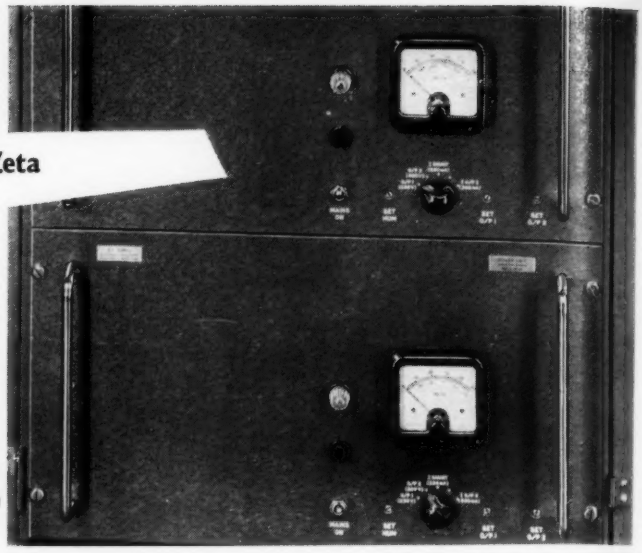
Sifam

Instrumentation . . . and Zeta



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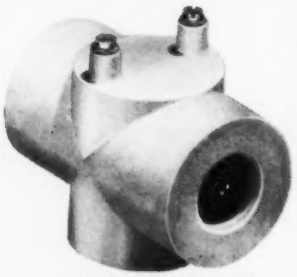

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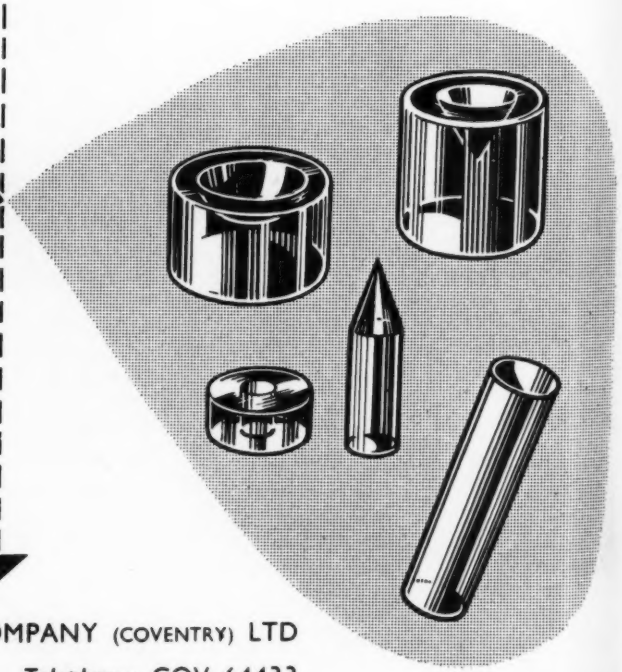

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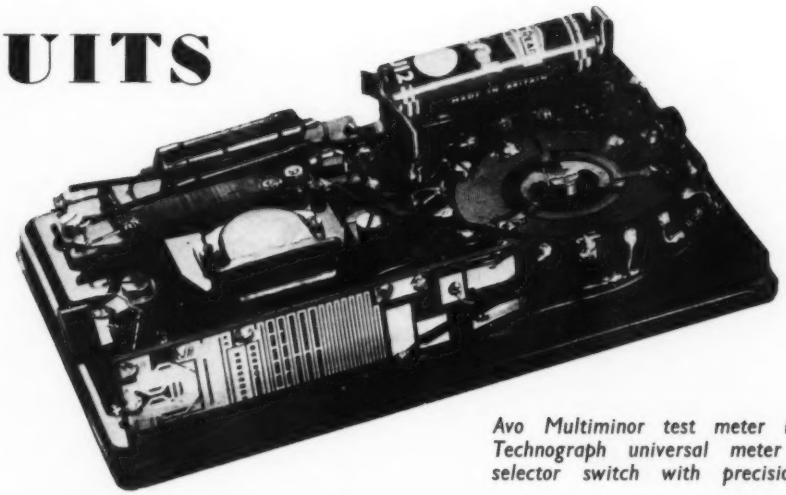

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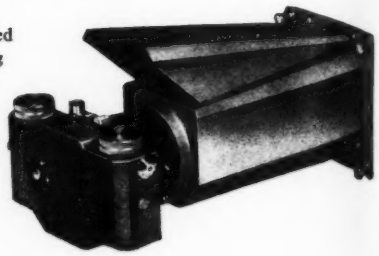

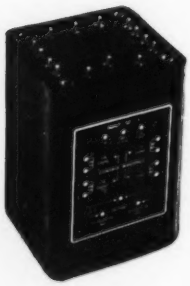

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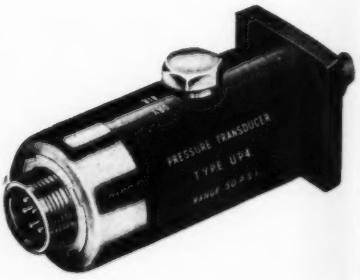

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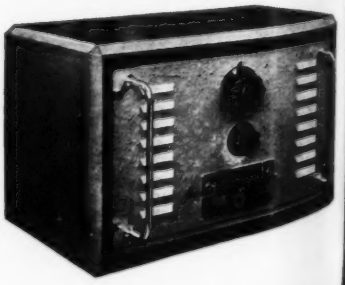

Full details of any of the above products available on application.

AD/571

INSTRUMENT Practice
AUTOMATION & ELECTRONICS

Editor: J. T. Miller, B.Sc., F.Inst.P.

VOL. 13. No. 5

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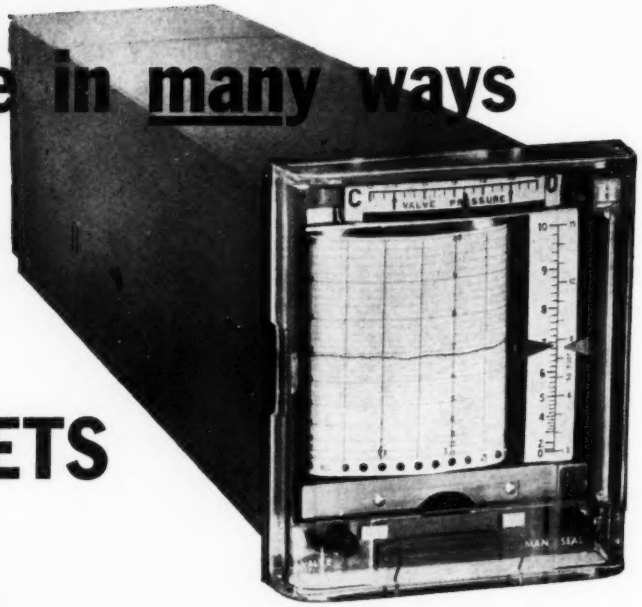

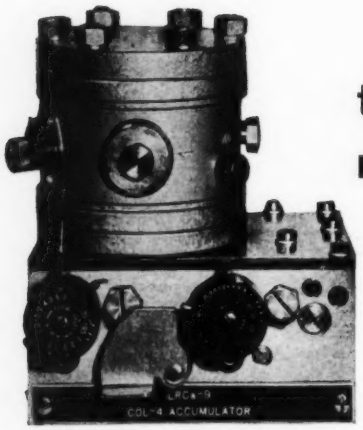

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COMMENTARY

R.E.C.M.F. Exhibition, 1959

A sheet of information, which is before the editor as he writes, is headed "Electronic Components Show"; and to any visitor to the 1959 exhibition of the Radio and Electronic Component Manufacturers' Federation this will seem the truer title. The products on view are now incorporated in every aspect of electronic engineering, including by no means a small percentage of electronic instrumentation. The prosperity of the electronic component industry is a reflection of that of those industries which use the components, and it is heartening to realise that the annual turnover has now reached £100,000,000. The export figures for 1958 were valued at £21,000,000 and during last year nearly 2,000 million components were manufactured. These figures are impressive ones.

The industry has had and, indeed, has many problems to solve. The reliability of an instrument, for example, is no better than the reliability of its components. Space has always been at a premium and components have in many cases reached the subminiature stage, but the reliabilities must be the same as those of the larger versions. Materials, again, must approach a standard of purity not contemplated even a few years ago. An example of this is the ratio of purity required in germanium or silicon for the manufacture of transistors: 1 part in 10^8. This standard, of course, brings an attendant problem, that of determining the purity value, and here electronic instruments have been devised to measure this factor. Another example is that of permanent magnet materials which have shown a steady development in characteristics. Research work undertaken by the industry results in an improved product, the benefits of which are received by the component users in which the instrument industry is prominent.

Electrical Engineers' Exhibition

The Electrical Engineers' Exhibition, recently held, attracted the record number of 68,249 visitors in five days. This is equivalent almost to a daily average of 14,000. The exhibition, of course, covers the whole of the electrical industry but there is always a solid core of instrument manufacturers present and to that extent, at least, the attendance figures are of interest.

Falling Demand?

An article in the *Times* of 7th April is headed "Falling Demand for Graduates Seeking Jobs in Industry". A sub-title states "Tighter Market Affects Scientists As Well As Art Students". The views of several university appointment boards have been asked, and these tend to confirm a slowing down of the intake of university graduates into industry. Definite figures are given of the needs of four large organisations and these are quoted below.

Organisation	*Intake Last Year*	*Intake This Year*
A	251	161
B	112	91
C	43	17
D	25	10

One may take these figures as authoritative. The big question is whether one can regard them as typical. If they are typical, then the situation requires some very serious thought. The above decreases are not small, on the average, and cannot be blamed wholly on to a trade recession or the prospects of a very competitive trade future. Sometime, one could envisage a slowing down of industry's need for technical personnel, but this should surely have been gradual and some years ahead rather than now. Two events may tend to aggravate the situation. The ending of national military service which will have a temporary effect, but the effect of the arrival of engineers and others holding the new diploma of technology may be more lasting. But none of the reasons given would seem wholly to answer the question.

Comparison with other countries is dangerous unless the whole background is presented, but in these columns we have more than once of late given figures of the rate of production of university graduates and others abroad. These do not, in the case of the two most prominent countries, show any signs of diminution. Could it be that we are reaching, because of our unique problems, a state of saturation well in advance of others?

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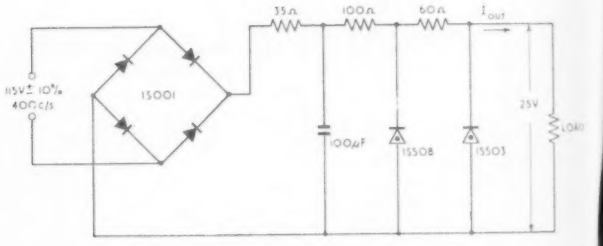
type	zener voltage Vz @ Iz volts	zener current Iz mA	zener impedance Zz (max) @ Iz ohms	reverse current LIb @ −10V 25° C µA	power dissipation P(max) Ts = 50°C watts	typical temp. coefficient %/°C
1S501	22	150	4	10	8	0.08
1S502	24	150	4	10	8	0.08
1S503	27	150	4	10	8	0.08
1S504	30	150	5	10	8	0.08
1S505	33	150	5	10	8	0.08
1S506	36	150	6	10	8	0.09
1S507	39	150	6	10	8	0.09
1S508	43	100	7	10	8	0.09
1S509	47	100	8	10	8	0.09
1S510	51	100	10	10	8	0.10
1S511	56	100	11	10	8	0.10
1S512	62	50	14	10	8	0.10
1S513	68	50	16	10	8	0.10
1S514	75	50	24	10	8	0.11
1S515	82	50	26	10	8	0.11
1S516	91	50	40	10	8	0.12

Actual Size



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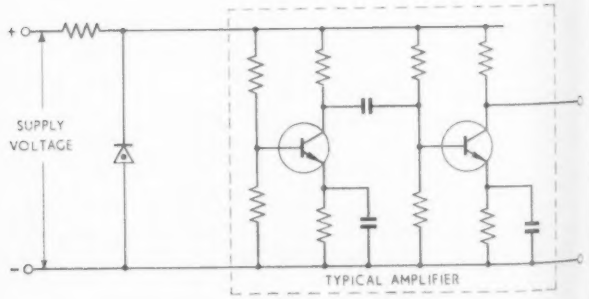

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Pattern-recognition Systems

A generalised scanner for use in studying pattern-recognition systems has been built and put to work by scientists at Bell Telephone Laboratories. This research tool, in conjunction with a digital computer, can be used to study any logical pattern-recognition system that could be devised.

A new pattern-recognition system also has been invented at Bell Laboratories. It employs a neuron-field system to transform complex patterns into simple patterns or dots.

The scanner was described in a paper presented by W. H. Highleyman and L. A. Kamentsky, of Bell Laboratories, at the Western Joint Computer Conference. This laboratory tool was developed as the most economical means to determine which of a variety of pattern-recognition systems could best achieve the ultimate goal, which is to feed visual information into machines without human intervention.

The device is suitable for scanning handwriting as well as various patterns, large or small, and has sensitivity to any two selected colours.

A cathode ray tube, flying-spot light source scans the pattern to be studied. The scan is programmed to move from any given point on the pattern to any other point in 200 microseconds, and then to succeeding points in the same constant time. Any path can thus be programmed into the scan.

The light source actually scans two areas at once: one containing the document under study, the other a blank piece of paper. Light reflected from a particular spot on the document is focused on a pair of photomultipliers, each sensitive to a different colour.

Meanwhile the light reflected from a corresponding spot on the blank paper is similarly focused on another pair of photomultipliers. Outputs of the photomultipliers for each colour are then subtracted, thus compensating for changes in cathode ray tube intensity, angles of reflection, and multiplier sensitivity. This difference is then quantised into two intensity levels. A second colour is particularly useful for providing position reference marks on the document.

The scanner has a resolution of 100 lines with 10,000 resolvable points and a scan field variable from one-eighth inch square to three inches square. With a magnetic tape input, it has a capacity of 60,000 instructions and can execute these instructions at a rate of 4,000 per second.

The output, which is also on magnetic tape, is produced in a way that makes it compatible with a digital computer. First, the programme for the scanner is written by the computer on a reel of tape. This reel is then placed on the output tape machine and the programme is transferred directly to the programme tape machine under control of a logic unit. Later, during the scanning programme, the timing of the output tape is controlled by the programme tape, so that although speeds of the tape machines may differ from each other and from the computer, the output tape will be compatible with the computer.

Before a pattern is scanned, a code identifying that particular pattern may be set into a toggle-switch pattern identification register. This code is written on the output tape during the scanning of the character and serves to identify it in later processing by the computer. Scan information also includes the quantised photomultiplier output information and the end-point co-ordinates for each scan segment.

Neuron-net System

In a separate paper, Dr. Kamentsky described a pattern-recognition method based on an array of neuron-like elements arranged in vertical and horizontal rows. The system can reduce line width, filter "noise" from the pattern, or extract identifying features of the patterns, such as intersections and corners. It performs these translations without the usual bit-by-bit operations of a digital computer or the complex logic and storage circuitry of earlier spatial systems. Each of the neuron-like translation modules will take inputs from many sources.

Each module has a responsive element whose threshold can be varied according to the programme. An array of individual sources of input information corresponds to the neuron array. In a typical connection, each input source has a connection to its corresponding neuron and also to each of the four neurons that are its nearest neighbours at either side, top and bottom.

To extract, for example, an identifying feature of the letter "T", the threshold could be set so that the neurons would respond only if they received inputs from the sources that correspond to three of their nearest neighbours, plus their own corresponding input source.

In the case of the "T", the only neuron to respond would be the one at the intersection of the horizontal line with the vertical line. Thus the "T" pattern is transformed into a single dot at the top centre of the field, which could be used as a recognition feature for the "T".

In a complete recognition operation, a sequence of similar spatial transformations is programmed. The revealed presence and absence of various features are recorded as bits in a features store. A set of these features gives a code that will identify the pattern.

Transistors in Measurement and Control — 1

By J. T. MILLER, B.Sc., F.Inst.P.

Insofar as instrumentation is concerned, transistors are becoming something more than a mere substitute for thermionic valves. It is proposed in a series of articles to review the part they play in measurement and control. It is felt that a brief discussion of the basic principles of transistors would not be inapposite to begin a review of transistor applications in this particular field.

Basic Principles of Transistors

THE impact of nuclear physics will have left few readers without some knowledge of the construction of the atom. A simple diagram of this is shown in Fig. 1. We have the nucleus N, with attendant electrons revolving in orbits round it. It resembles the planetary system with which we are familiar, the sun representing the nucleus, and the earth and other planets revolving round the sun, corresponding to electrons. If each electron carries a negative charge, the nucleus carries a positive charge numerically equal to the number of negative charges carried by the electrons. This renders the resultant charge on the atom zero.

Each electron possesses energy, partly kinetic and partly potential, but the total energy is less for electrons in orbit nearer the nucleus than for those farther away. Those in the outermost orbit will have the greatest energy, and hence will require less additional energy to remove them from orbit than the others. The electrons in this outermost orbit are termed "valence" electrons and the number contained therein has a bearing on the properties of an element.

Now, it is possible for a valence electron of one atom to combine with another from a neighbouring atom to form a "pair", the two electrons then going into orbit around the two nuclei in the manner of Fig. 2. Here N_1 and N_2 are the respective nuclei of neighbouring atoms and E_1 and E_2 the respective valence electrons.

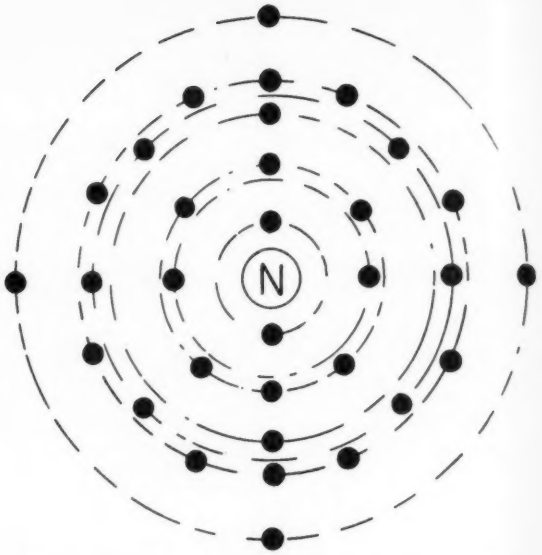
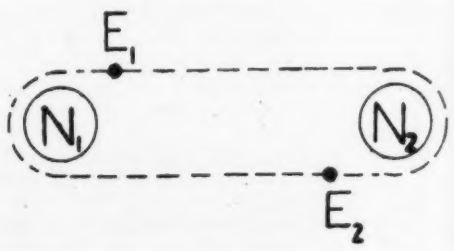


Fig. 1. *Diagram of orbital arrangement of an atom*

Next consider a specific element widely used in transistor manufacture. A germanium atom has four valence electrons in the outermost orbit, which means that each can be associated with a valence electron from neighbouring atoms to form a pair in the manner of Fig. 2. The result is shown diagrammatically in Fig. 3 where N_1 is the nucleus of the original atom, and N_2, N_3, N_4, N_5 the nuclei of neighbours. E_1, E_2, E_3 and E_4 are the valence electrons associated with N_1. We have, thus, a form of bonding leading to a basic crystal structure. In the case of germanium each atom can be considered as being at the corners of a regular tetrahedron, the arrangement being repeated throughout the structure (Fig. 4).

We have next to consider the effect of removing a valence electron from a bond as described above. This leaves the bond with one electron and a gap where the other electron has been removed. The gap, physically an electron vacancy, has received the name "hole"—suggested broadly by the fact that another electron may "fill" the gap left in the bond. This electron can be "filled" from a neighbouring bond, but, in turn, a "hole" will be left in the latter. There is a significant effect in removing an electron from a bond: the hole

Fig. 2. *Electrons from neighbouring atoms forming a "pair"*



receives an apparent positive charge. Suppose that a potential difference is applied across the substance, the positively charged holes will progress to the negative electrode, and a current will flow. Any free electrons will proceed to the positive electrode contributing to the net current flow.

Semiconductor Behaviour

Now let us proceed further and introduce the atoms of other elements. Let one have five valence electrons and another three compared with the four of germanium. To be more specific, consider first an atom of arsenic, antimony or phosphorus with five valence electrons. Obviously four of the valence electrons can combine with four germanium valence electrons to form pairs. But one electron is left free, and if a number of arsenic atoms, for example, are introduced into a sample of germanium, the application of a potential difference will cause a current to flow, the value depending on the concentration of arsenic atoms. Thermal agitation may contribute to the presence of a few positive holes and free electrons to contribute to the current flow, but the electrons are the majority charge carriers.

In contrast to arsenic, suppose atoms of indium, gallium or boron with three valence electrons are introduced into a sample of germanium. We now have a reversal of affairs. The three indium valence atoms will combine with three germanium valence atoms, but one germanium electron will be left without a partner, giving the effect of a pair from which one electron has been removed. An apparent hole has been created with positive charge. Again, the application of a potential difference causes a current to flow with the positive holes as the majority charge carriers.

Arsenic and indium, whilst they themselves may be pure materials, are regarded as impurities when introduced into germanium. Germanium with arsenic (or similar element) added is termed n-type germanium. Germanium with indium (or similar element) introduced is known as p-type germanium.

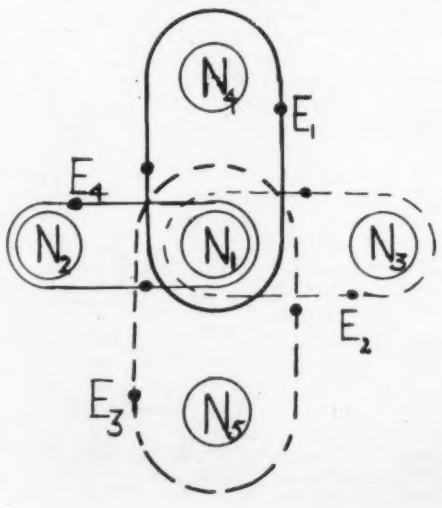


Fig. 3 (left). Formation of "pairs" by an atom with four valence electrons

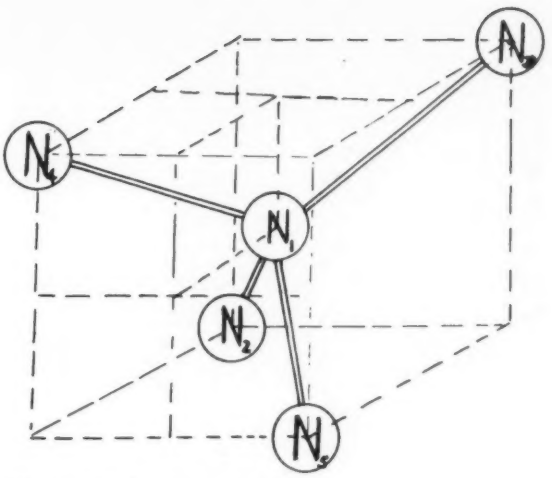
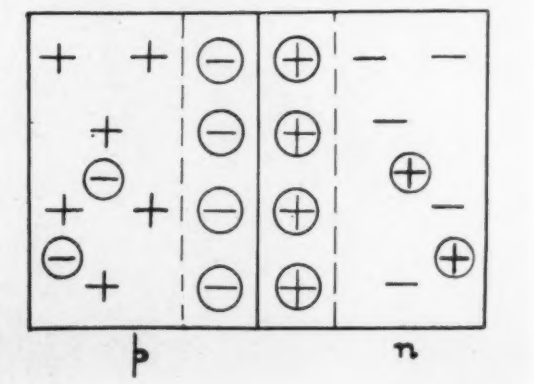


Fig. 4. Model of crystal structure

The next step is to examine what occurs if a junction is made of the two types with an interface as in Fig. 5. The two substances are electrically neutral, but there will be a relatively high concentration of electrons in the n region and few in the p region. A concentration gradient exists, therefore, across the interface, and at the first sight it would appear that a large transfer of electrons would take place across the interface until concentrations on both sides were uniform. A similar reasoning would apply to the positive holes which possess a relatively high concentration in the p region and few in the n region. Such an unrestricted transfer would result in the establishment of a current flow with a resultant effect on neutrality. To prevent this some kind of barrier must be established.

The phenomena, so far discussed, have been considered as occurring at room temperature. Sufficient thermal agitation occurs at this temperature to cause

Fig. 5. p-n junction. The signs within circles represent fixed charges and without circles, mobile charges



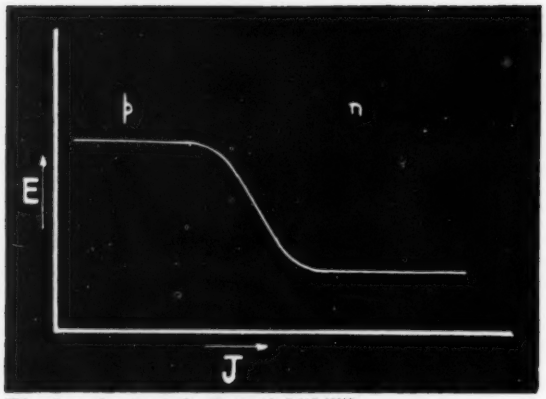


Fig. 6. A curve of a potential "hill"

thermal diffusion of the charge carriers, i.e., electrons and holes, across the interface. When this happens, the loss of electrons causes the n region to receive a net positive charge and the p region a net negative charge. The result is that, ultimately, electrons seeking to enter the p region are repelled by the net negative charge, and positive holes seeking to enter the n region are repelled by the net positive charge.

An alternative conception is that of a potential "hill" up which an electron, for example, must climb from one region if it wishes to reach the opposite region. In the reverse direction the picture is that of an electron sliding down the "hill". The hill effect may be represented by a diagram shown in Fig. 6, where E is the electron energy and J the junction traverse.

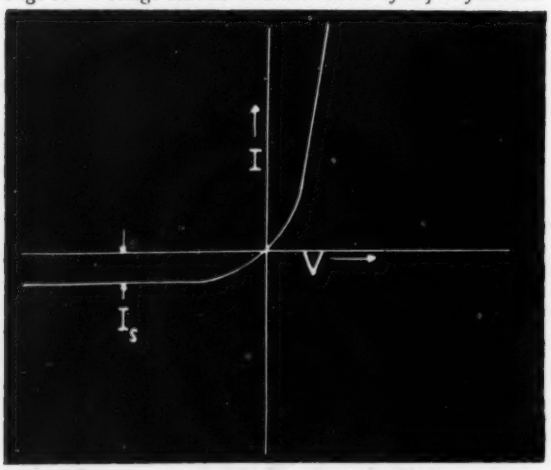
If a d.c. voltage is connected to the junction, positive pole to the p region and negative pole to the n region, the applied voltage opposes that due to the barrier and the latter becomes thinner, allowing a transfer of electrons and holes to take place. When the applied voltage overcomes the potential barrier voltage, the junction behaves as a normal resistor.

If a d.c. voltage is applied in the opposite direction, with the positive pole to the n region and negative pole to the p region, the applied voltage aids that due to the barrier which tends to become thicker and, theoretically at least, no current can flow until the material breaks down electrically.

In actual practice, some minority carriers, electrons on the p side and holes on the n side near the interface, will possess sufficient energy to journey across the barrier giving rise to a small current termed reverse saturation or reverse leakage current. This current remains constant whatever the barrier thickness.

The net result is that with applied voltage in one direction a relatively large current will flow and with the applied voltage in the opposite direction only a small current will flow. The voltage-current curve is indicated in Fig. 7. It can be seen at once that this is the characteristic of a rectifier.

Fig. 7. Voltage-current characteristics of a p-n junction



Junction Transistors

Let us proceed from rectification to the next stage of development. Consider the construction of Fig. 8. Here we have an n-type element sandwiched between two p-type elements, giving a formation known as p-n-p. One p-type element is termed the emitter, the n section the base and the other p-type element the

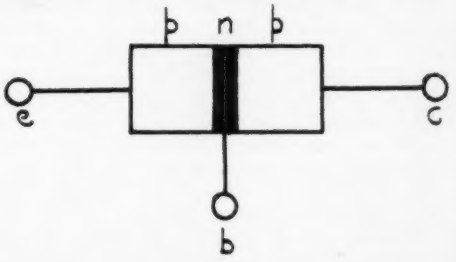


Fig. 8. Diagram of p-n-p junction

collector. The reason for these designations will be apparent from the following reasoning. Suppose that the emitter is made with a much lower resistivity than that of the base. This could be arranged by "doping" the emitter with a much larger number of impurity atoms compared with the base. The unit is then biased in the manner of Fig. 9. The forward current across the emitter-base junction A will consist mainly of holes. These diffuse into the base, normally very thin in section. The majority of holes will reach the collector-base junction B which is biased in the reverse direction to A. B will collect the diffused holes and add them to its own current. The ratio of change in collector current to emitter current is defined as the current gain α. Some small current will be taken by the base leg. Then

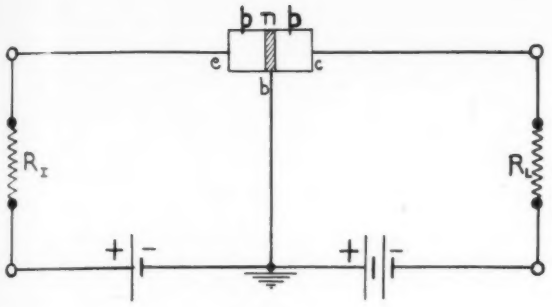
$$\delta I_C = \delta I_E - \delta I_B \quad \ldots\ldots\ldots (1)$$

where δI_B = the change in base current for a change δI_E in emitter current

δI_C = the change in collector current for a change δI_E in emitter current.

If we divide the above equation by I_E on both sides,

$$\frac{\delta I_C}{\delta I_E} = 1 - \frac{\delta I_B}{\delta I_E} \quad \ldots\ldots\ldots (2)$$



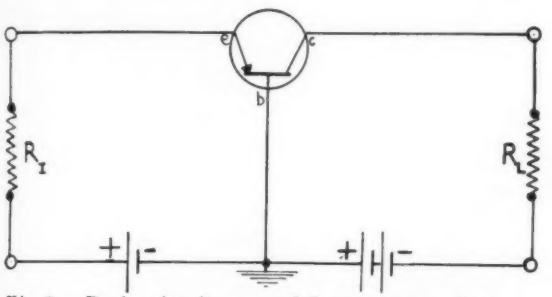
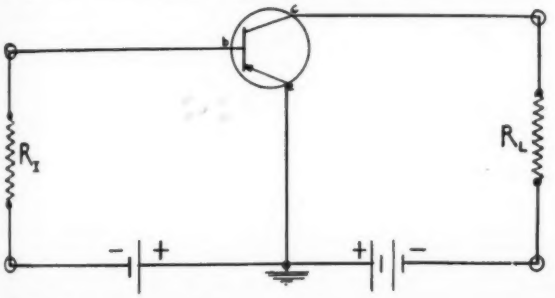


Fig. 9. *Basic circuit—grounded or common base*

Fig. 10. *Basic circuit—grounded or common emitter*



Grounded or Common Base Connections

The left-hand side of the equation is, by definition, the current gain. In this particular case the gain is given the designation a_{CE}: the gain between collector C and emitter E. Fig. 9 is known as the *grounded* or *common base* arrangement, the base in this case being the common electrode between emitter and collector.

It can be seen that a_{CE} is always less than 1 from equation (2). In well designed transistors, however, values of 0·98 or 0·99 are common.

Observe now the significant feature of the arrangement of Fig. 9. The input resistance is relatively low. A typical value is 25 ohms. The collector to base resistance, on the other hand, is comparatively high, say about a megohm. Consider a signal of 1 mV injected into the input circuit. With an input resistance of 25 ohms, the current is 40 μA. In the ideal case, all this current appears in the collector circuit. Giving a value to R_L of 10,000 ohms, the voltage appearing across it is 0·4 volts. Thus, there is a voltage gain of 400. The corresponding power gain can also be shown to be 400.

It would seem, therefore, that we have in the basic junction transistor, as we may term the construction of Fig. 9, a very useful amplifying device.

Grounded or Common Emitter Connections

An alternative scheme of connections is shown in Fig. 10. This is known as the grounded or common emitter connection since the input leg is now the base, and the electrode common to base and collector is the emitter. The current gain in this case is designated a_{CB} the gain between base B and collector C. Since

$$a_{CB} = \frac{\delta I_C}{\delta I_B} \quad \ldots\ldots\ldots\ldots (3)$$

it may be deduced that

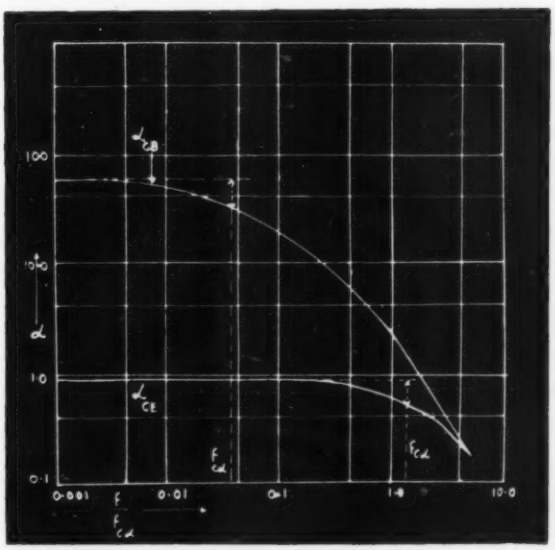
$$a_{CB} = \frac{a_{CE}}{1 - a_{CE}} \quad \ldots\ldots\ldots\ldots (4)$$

Now a_{CE} is always close to 1, e.g., 0·98 or 0·99, for example. a_{CB}, therefore, reaches relatively high values. Indeed for $a_{CE} = 0{\cdot}99$, $a_{CB} = 99$. The high current gain is one of the factors tending to render the common emitter arrangement more popular than the common base. There are one or two drawbacks particularly in the effect of frequency on current gain.

Frequency Effect on Current Gain

With one application of the transistor established as an amplifier, it is important to consider the effect of frequency on characteristics, particularly the current gain. It will be found that the gain is constant over a range of low frequencies, but as the value increases a tends to fall in the manner of Fig. 11. Observe that a_{CE} is constant over a far wider range than a_{CB}. A useful parameter to introduce here is the cut-off frequency. This is defined as the value at which a_{CE} or a_{CB} reaches $1/\sqrt{2}$ or 0·707 of its low frequency value, and is given the designation $F_{C\alpha}$. Briefly, this effect may be explained by noting that different holes take different paths across the base and a dispersion of transit time takes place. When the time differences are

Fig. 11. *Relationship between current gain and frequency*



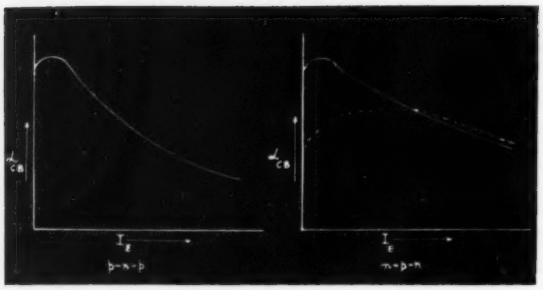


Fig. 12. *Variation of emitter current I_E with current gain a_{CB}*

of the order of the period of the a.c. signal, interference takes place and a falls in value.

Apart from ohmic resistance, there are one or two capacitances involved in transistor construction which tend to make it frequency dependent. The major one is the collector-base capacitance. The effect of this is evident at higher frequencies and is fully explained in the standard texts in the bibliography.

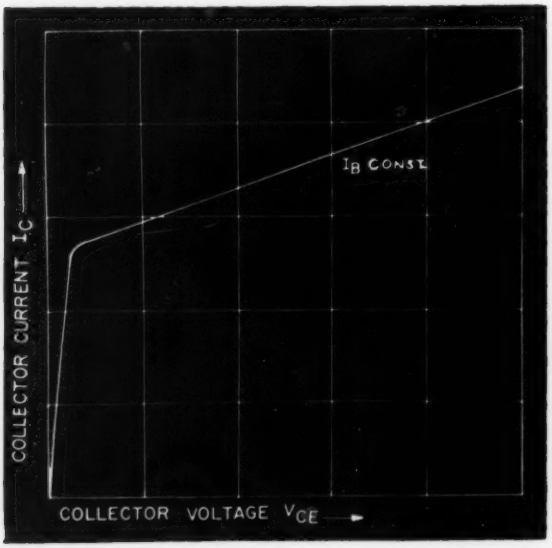
Emitter Current Effect on Current Gain

A rather more serious parameter change is shown in Fig. 12. This indicates the current gain a_{CB} variation with emitter current for a typical transistor. The second curve relates to an alternative form of transistor construction which has not been mentioned so far—the n-p-n. Here a thin slice of p material is sandwiched between two elements of n material. Note that the n-p-n arrangement gives a flatter curve in actual practice.

Circuit Representation of Transistors

It is unfortunate that more than one symbol has been used for a junction transistor. The principal ones are shown in Fig. 13. Confusion can be minimised if it is remembered that the inclined arrow is the emitter, the inclined line is the collector, and the vertical line, solid or open block is the base.

Fig. 14. *Typical collector voltage-collector current curve for a common or grounded base circuit*



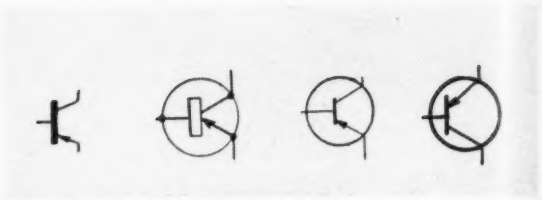


Fig. 13. *Typical transistor symbols*

Temperature

The effect of thermal agitation has been observed under semiconductor behaviour. It may be supposed, therefore, that temperature will exert a large influence on the functioning of a transistor. Because of this temperature factor many characteristics are specified at a particular ambient temperature, 25°C being a common value. At the same time, maximum ratings are also essential and these are normally given in manufacturers' data sheets.

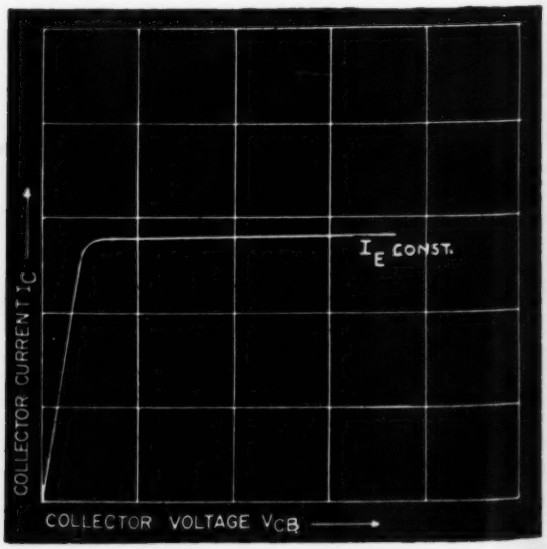
Basic Design Parameters

We have seen in the foregoing explanations the effect of two or three physical factors on the operation of transistors. For design purposes operation under specific conditions must be known. The following are some of the main factors on which data is supplied by a transistor manufacturer.

Collector Bias Voltage

This is an important parameter which effects the collector current. Normally it is expressed with reference to the base in the common base circuit (V_{CB}) or the emitter in the grounded or common emitter circuit (V_{CE}). Sets of characteristic curves may then be drawn up with collector current I_C plotted against V_{CE} or V_{CB}. With the common grounded emitter connections, a family of curves may be drawn up for different values of base current I_B. With the grounded or common base circuit, a similar family of curves may be constructed for different values of emitter current I_E. Typical examples are shown in Figs. 14 and 15.

Fig. 15. *Typical collector current-collector voltage curve for a common or grounded emitter circuit*



Saturation or Cut-off Current

In dealing with semiconductor behaviour, the phenomenon of saturation current was noted. If the bias on the input side of a transistor is removed, a small standing current will still be present in the collector circuit. This is designated I_{CO} and is normally only a few microamperes. This factor is temperature dependent to a high degree.

Collector Dissipation

It has been noted that the saturation or cut-off current is temperature dependent. Let us consider a possibility. An increase in ambient temperature could increase I_{CO}. If the power dissipation is dependent on I_{CO}, this too could increase and further raise the junction temperature. In turn, this could increase I_{CO} and the cycle could be repeated. There may be a tendency, therefore, under certain conditions, for instability to be established.

A maximum junction temperature is normally stated on data sheets. Some figures taken from a commercial transistor, the type 2S004 of Texas Instruments Ltd., indicate the variation of maximum ratings with temperature:

Collector dissipation at 25°C	150 mW
Collector dissipation at 100°C	100 mW
Collector dissipation at 150°C	50 mW

Subsequent articles will consider other parameters, n-p-n transistors, phototransistors, applications and so on.

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NEW PATENTS

Patent No. 797,420. Automatic Programme Control Systems.

The English Electric Company Ltd. (Inventors: B. T. Downing and W. D. Worthy). (*Application No.* 25377/57, *divided out of No.* 707,419.)

Automatic control of some quantity over a period which may extend to several hours or even days results in a minimum of attention and elimination of an error or oversight on the part of an attendant. A particular field cited is the control of furnaces. Under the principle of the invention the magnitude of a quantity is controlled as a function of time in response to control information derived from a record of digitally-coded numerical data. A recorded item comprises at least two closely-adjacent parts which are read in turn as the record passes through a reading unit at a steady rate. Each successive item of information is thus read after a time proportional to its position on the record. Means are provided for adjusting the controlled quantity in accordance with each successive reading, for retaining the quantity at the adjusted value until the next reading and for accelerating the movement of the record between the reading of each part of a recorded item. The record is moved in discrete steps by an electrical drive means which respond to electrical pulses supplied at equal intervals of time by a pulse generator.

Patent No. 797,503. Automatic Control Systems Especially for Machine Tools.

Electric & Musical Industries Ltd. (Inventors: R. E. Spence and R. H. Booth.) (*Application Nos.* 29126/53, 32055/53 *and* 32056/53.)

The invention relates to systems for controlling the angular displacement of a shaft in an automatic machine tool as a function of a variable in response to numerical instructions fed to the machine. To provide continuous control for the shaft it is necessary to interpolate between the numbers which indicate the angular displacement which the shaft is required to assume at discrete times. A suitable interpolation device, described in Patent No. 796,994, requires input signals in voltage analogue form. The numbers are usually derived from a punched tape in which the numbers are recorded in digital form, necessitating means for converting the numbers to analogue form before feeding them to the interpolating device. The attainment of the necessary accuracy, say of one part in ten thousand, in setting up and interpolating between the voltage analogues involves practical difficulties which are, it is claimed, reduced by the present invention.

Patent No. 797,587. Thermal Overload Relays for Protection of Electrical Apparatus.

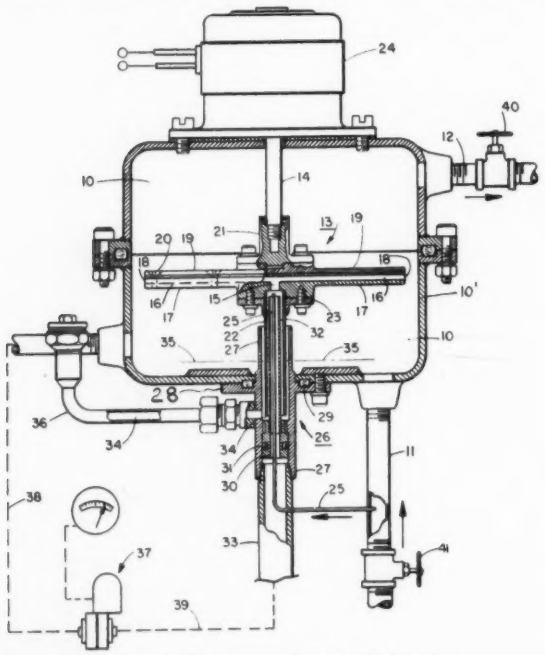
Brookhirst Switchgear Ltd. and Edmund Morton Butterworth. (*Application No.* 22720/54.)

This invention covers the provision of a thermal overload relay device for protection of polyphase alternating current circuits. It also relates to apparatus comprising a series of heating units, one for each phase with associated bi-metal temperature responsive elements which, after predetermined deflection, actuate a switch controlling a device acting as a cushion absorbing excessive movements of the temperature responsive elements due to the latent heat of the heating units after they have been disconnected from the supply. The device also provides a calibration lever for setting the device to operate at a predetermined overload, a

bi-metallic element to compensate for changes in ambient temperature with an adjustment device for calibration of this element relative to the calibration lever.

Patent No. 797,643. Measuring Fluid Density.
The Foxboro Company (U.S.A.). (*Application No.* 23492/56.)

The method adopted in the invention to determine the density of fluids, especially gases, comprises passing a continuous flow of sample gas through a chamber. The chamber contains an impeller disc unit through which gas is conducted by means of a central passage and radial passages. As the gas is expelled from the radial passages into the gas filled chamber a pressure reduction is caused, providing a differential pressure with respect to the gas pressure in the sample chamber, which is a measure of the density of the gas in the



Schematic of unit for measuring fluid density

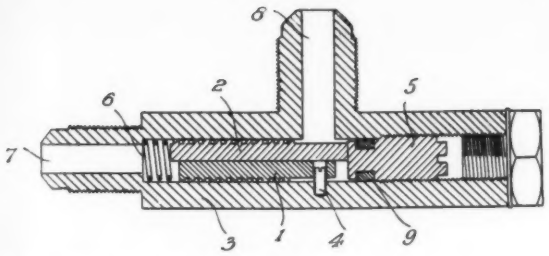
impeller passages. In the drawing reproduced above the chamber 10 is provided with a gas sample inlet pipe 11 and outlet pipe 12. The centrifugal gas impeller disc unit 13 is driven to rotate horizontally by an electric motor 24 through a shaft 14. The disc unit is provided with a central passage 15 connected with radial passages 16. Gas is admitted to the central passage 15 and the radial passages 16 by the small pneumatic passage tube 25 sealed into the assembly 26 passing through the bottom of the chamber 10. In this assembly, as a sealing arrangement between the gas in the chamber 10 and the impeller inlet and the pressure take-off sleeve 32, a body of mercury 34 is introduced between the outer sleeve 27 and the sleeve 32—the mercury being supplied from a "head" of mercury in a side pipe 36 with a closed outer end and an inner end open to the mercury body in the telescoping assembly 26. For a differential pressure measurement which is representative of the density of the gas being measured a measurement device 37 is shown by way of illustration which may be one of those described in Patent No. 672,879. Other forms of application of the invention are described in the specification.

Patent No. 797,676. Variable Electric Resistor Devices.
G. V. Planer Ltd. (*Inventors: Albert Loro and G. V. Planer.*) (*Application No.* 10738/55.)

The invention is concerned with devices, potentiometers and the like of the film type comprising an electro-conductive film on an insulated base, the resistance being varied by the movement of a wiper across the film. The patent covers in particular devices in which the conductive film is of the "meandered" type in which the film is arranged in a pattern such as to result in an increased length of resistance path. Such devices present certain difficulties because the thin film is easily damaged by the action of the contact wiper which causes changes in resistance and sometimes severing of the film after only a few sweeps. These disadvantages are claimed to be overcome in the invention by reinforcing part of the meandered film by bands of electrically conducting material applied to the film—such reinforced portions comprising the track of the contact wiper. Such bands may be applied by electroplating, printing, spraying, evaporation or painting on or the like. The bands may be applied to the conductive film either overlying it, underlying it or both. Various reinforcing materials may be used but rhodium metal is preferred in view of its excellent wear resistance and chemical stability.

Patent No. 798,170. Flow Controlling Device.
The British Thermostat Company Ltd. (*Inventor: J. E. Sherlock.*) (*Application No.* 27651/55.)

The flow controlling device referred to is more particularly for controlling the refrigerant from the high to the low pressure sides of a refrigerating system. For this purpose the systems in common use are expansion valves and restriction tubes. For systems in the range of the lower horse-power ratings the latter system has advantages over the former and is generally accepted by the refrigerating industry. There are, however, certain disadvantages about the system including liability to blockage from foreign matter in the system, variations in the flow of refrigerant being effected by changes in viscosity and specific volume in proportion to the length of the tube and the amount of restriction offered by restricting tube being fixed and not adjustable. Attempts to overcome the first and last of these disadvantages have not proved satisfactory and it is claimed that the invention provides an improved form of adjustable flow restricting device which is less susceptible to blockage and in which a minimum restriction (maximum flow) setting serves as a flushing position to which the device can be temporarily adjusted should blockage occur. Less susceptibility to viscosity and specific volume variations in the refrigerant are also claimed. In the drawing reproduced the device comprises a screw threaded plug



Schematic of flow controller device

in two sections 1 and 2 as though divided along a plane parallel to its axis. These two sections are in sliding relationship upon the two flat faces and are contained in a closely fitting sleeve 3. One section of the plug is fixed in the sleeve by the screw 4 while the other can slide in the sleeve being adjusted for position by the screwed member 5 which when rotated clockwise urges the sliding section downwards against a return spring 6. The refrigerant enters through the inlet port 7 and passes through the helical groove formed by the compound screw thread to the outlet port 8. The rate of flow will depend on the degree to which the helical grooves in the sliding and fixed sections of the plug are in register: maximum flow when they are in exact register and minimum flow when almost out of register.

Patent No. 798,191. Magnetically Operated Electrical Switching Devices with Conductor-Liquid Contacts.

National Research Development Corporation. (*Inventor: H. J. Nicholls.*) (*Application No.* 24336/55.)

Many electrical switching devices or interrupters for repeatedly interrupting electrical currents operate by rapid making and breaking of contact between solid current-carrying contact pieces and are subject to arduous work and are not very reliable. The object of the invention is to provide a reliable switching device which can repeatedly interrupt an electrical current without a make and break action between solid contacts. This is effected by the use of a sealed tube in the form of a closed loop, entirely filled with an endless chain of two or more liquid sections made up of alternate conducting and non-conducting liquids with one or more pairs of electrical contacts in the walls of the tube spaced apart from each other transversely across the tube. A conducting path is formed between the contacts of each pair when the conducting liquid lies between them and contact is broken when the non-conducting liquid comes between them. A magnetic field is concentrated across the path of the current flow between each pair of contacts in a direction at right angles to the direction of the current flow and the longitudinal axis of the tube. When the current passes between the contacts the current-carrying liquid is driven along the tube by the interaction between the magnetic and electrical flows in accordance with Fleming's Left Hand Rule. Thus the conducting path is formed between the two contacts only when a section of the conducting liquid passes between them. Various applications of the switch and methods of adjusting the operating frequency are described in the specification.

BOOK REVIEW

Introduction to the Design of Servomechanisms

By J. L. Bower and P. M. Schultheiss. John Wiley and Sons Inc. £5 4s. 0d. 510 *pages.*

Servomechanisms are a well established branch of engineering technology which is being applied in an ever increasing amount to the solution of complex problems which involve kinetic closed loop control. The purely theoretical treatment of servomechanisms has formed the subject matter of a great many books written within the last few years but there are still relatively few which deal with the end product of servo theory, namely a working servomechanism which will achieve a specified performance in a particular task and this book sets out to give an integrated presentation of the principal avenues of approach to the design of feedback systems.

Dr. Bower has had a long and extensive practical experience in this field while Professor Schultheiss has specialised on the theoretical approach, so together they form an excellent partnership to deal with the book's title. In one respect this is perhaps a little misleading to many British readers who tend to associate the word "introduction" with a work intended for newcomers to the subject which is being introduced. The present book contains 510 pages, and its chapter headings include Harmonic Analysis, Series Equalisers, Performance Criteria and Design Techniques, Root Locus Technique, Statistical Considerations and Non-linearities in Servomechanism Design. If all of this matter is needed to "introduce" servo design procedure the young engineer with servo aspirations may become somewhat apprehensive in his contemplation of the future. However, Basic Concepts and Mathematical Introduction are the headings of Chapters 1 and 2 and as one follows in the text the logical development of these essentials the impression is soon gained that here is an excellent book for the engineer who has already encountered servo problems and realises that the successful solution of all but elementary ones requires most of the matter which is covered in the book. It contains a large number of problems, but their value would be considerably enhanced if guides to their solution were given, even if space precludes complete solutions.

The concepts of designing a system for a limited linear range, and the deliberate use of non-linear elements to improve system performance, are dealt with well and the now popular root locus technique is covered fully, in addition to the use of the Bode Diagram. Finally, there is a valuable Appendix on servomechanism components in common use and their transfer functions, without which any book on design would be incomplete.

Summing up, the book should go a long way to meeting the needs of servomechanism engineers who have a sound mathematical background and although its price is rather high nevertheless they are unlikely to require a more advanced treatise for some time.

E. B. PEARSON

Powers-Samas programme controlled computer (P.C.C.)

By R. H. WILLIAMS, A.I.B., F.Inst.D.
Managing Director, Computer Consultants Limited

Computers and tec

Part I. Introduction

PEOPLE are finding it more and more difficult to decide whether they should accept computer equipment that is actually available and tailor their requirements to suit the characteristics of available equipment, or whether they should be adamant about their requirements, and refuse to consider installing any equipment, which means that their needs would have to be curtailed or changed to their disadvantage.

In most cases, it would be extremely fortuitous for a potential computer user to design an intended system, and consequently find that there was precisely suitable equipment available to meet his requirements at the right price. In setting up a computing system, there are several inter-acting factors to be taken into account.

One possible approach would be to seek a compromise on what is available and what is required. With computers, where a saving or loss could turn on a very small item of system design which has to be repeated thousands of times, this method of approach could be extremely dangerous.

There have been all too frequent instances in the past where a very elaborate and clever conception has been meticulously drawn up and apparently supported by extensive mathematical and physical truths, only to find that the whole project ultimately rests on an "if", very often depending on human behaviour. To give an instance, at present the output printing situation of many computing systems manufactured and installed in Britain depends upon unsatisfactory printers. These printers do not operate sufficiently fast to allow enough material to be printed within a limited time cycle, and thus do not justify the economic use of the system. This time cycle is in most cases governed by outside factors as ordinary as postal arrival and departure times, which mean that the day's printing output of say despatch notes has to be completed in a very limited period, with allowance made in the estimates to cover inevitable peak periods.

Obviously at this stage of computer development, a stalemate position could very well arise insomuch that if a potential user was dogmatic about his requirements, and the computer manufacturer was equally dogmatic about what he was prepared to develop, particularly for a limited market, then no progress at all could be made. Enormous sums have been sunk by the manufacturers into computer research and development, and quite reasonably they are now becoming more conscious of the cost of this development and less prepared to enter into work for which there might be only a limited market. The point of view taken depends a great deal whether one is intending to use computing equipment or to manufacture it.

What equipment should be developed depends upon the detailed stated requirements of the potential user. These are not quite as easily defined as might be at first supposed, because in many cases, the potential user has not enough experience to think up the full computer scope of the particular work on which he is engaged. His judgment tends to be coloured by past methods of procedure, and only too often the computer application could mean a complete reversal in thought, and in the sequence, of the steps necessary to carry out a particular task.

Existing computer equipment is often quoted by the manufacturer at a delivery date 2 or 2½ years hence. When some potential users learn this, they tend to sit back to wait until the delivery date is nearer, completely forgetting that it would probably take them the full 2 or 2½ years to prepare their own organisation for the forthcoming changes which were necessary and to prepare and check the necessary programmes.

Fortunately for all concerned, there are exceptions to all generalities. There are exceptions to what computer manufacturers are prepared to develop, even at this stage; there are exceptions among users, some of whom are prepared to plod on, and realise that all progress in the past has been won by hard work and the will to keep on trying. In fact any organisation must seek to progress, or it will inevitably fall back, as its competitors make improvements.

Having, therefore, spent this time on generalisation, let us become more positive, and do this by generalising still a little further, this time on the use of computers

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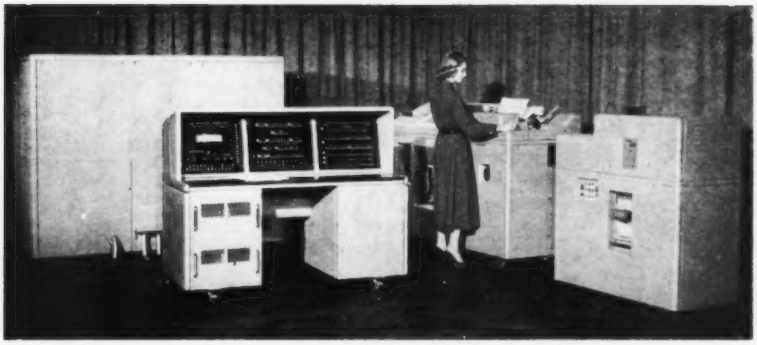


HEC general purpose electronic computer, Type 1201, *manufactured by I.C.T. Ltd.*

and also any type of office equipment. Following this we can consider specific problems, and see how they might best be approached.

The "gimmick age" of the computer is long past, and one of the first considerations which will govern any type of office installation is whether or not it will be financially advisable to make the change. The cost of installing equipment, including computing systems, does not start or end with the purchase or rental price. There must be a satisfactory place to install the equipment and in some instances this will mean air conditioning and quite probably considerable structural alterations, including the possible strengthening of floors. In addition it will be necessary to use ancillary equipment such as filing cabinets, etc., and provision has to be made for spares as well as new stationery, which tend to be originally forgotten in the excitement of dealing with the main pieces of equipment.

It may well be that the accommodation position will ultimately be improved both physically and costwise by the installation of a computing system, by freeing more staff to work elsewhere. And it may be that no structural alterations are required, particularly in the case of some of the small computers.

A great deal will depend on the way the system is planned and whether the take-over from the existing installation to the computing system will be on a side by side basis, i.e., introducing the new equipment while still continuing to use the old method, until the new machinery has proved itself. This method of take-over could be quite an expensive business, and must be borne very carefully in mind when designing the overall system.

In some cases it is easier to take over from an existing punched card system to a computing system than it is from an existing keyboard system. But in other cases the method of carrying out the work on a computer, as opposed to a punched card system, could be so radically different that the mere fact of seeking to make parts of the old system suit the new could unnecessarily complicate the requirements of the new system. This applies particularly if any sorting is required, as sorting techniques on punched cards and on computers using magnetic tape are completely different, and more will be said about this in a later article.

It is very important when considering the cost and when making the appropriate estimates that the actual practical operating speeds of equipment should be ascertained, i.e., speeds taken as an average under realistic day-to-day working conditions, and not short trial runs under ideal conditions, which often bear little relation to true operating speeds.

The speeds of various machines will, in all probability, be reflected in the costs, and it should be borne in mind that if two machines are sufficiently fast, the fact that one is faster than the other is irrelevant. This applies particularly to the speed of the central computer itself. Most central computers now are input-output limited. That is to say, the speed of operation in the computer itself is faster (often many times faster) than the rate at which it can read input information, or produce or print output information.

The input/output speeds of computers are still relatively slow, particularly so if they are not using magnetic tape for this purpose. Most present-day computers were originally designed as scientific machines, where the amount of actual computation to be carried out was usually much greater than the amount of information which had to be fed in or produced as an answer.

In time to come when businessmen have learnt to use computers, and have developed confidence in their reliability, it will be possible to get a computer to share its time and carry out more than one particular task at a time. From a practical commercial application point of view, this development is still some considerable way off. Owing to inexperience, there will certainly be idle time, and due allowance must be made for this when estimating the cost factors. This idle time should not be confused with machine breakdowns, but results from such facts as an operator feeding in the wrong batch of cards or writing over existing information on magnetic tape, and the several other things, which he or she knows quite well they should not do, but which occur because they are human. These mistakes often mean that certain totals cannot be balanced, and consequently the procedures have to be returned to a certain "breakpoint" and carried out for a second time.

Again, when choosing equipment, it is usually better in the long run to go in for a quality product, and computer manufacturers have in some instances sometimes raised the quality of their products a little too high, particularly if these are rated on price alone.

Some British equipment on the face of it appears cheap compared to foreign products, but prices very often relate to basic computers, which are so basic that

they require very considerable and expensive buffering if they are to be used with magnetic tape or in some cases any type of peripheral equipment. On the total cost basis, the more expensive product using built-in standard buffering and six tape units will be cheaper than a lower priced computer, without this facility, used with the same number of tape units.

This cost difference also shows up in the overall price of some computing systems, which have no extras to be paid for. Ostensibly cheaper systems sometimes have a considerable number of extra charges such as installation costs, carriage and spare parts, etc.

One has also to consider the quality of the work which it is intended to produce. There must be an adequate operating margin, for a tight time schedule could be not only embarrassing, if breakdowns occurred, but could be vital to the conduct of the user's own business.

There is a tremendous difference between doing a job well and merely getting by, and the equipment used, particularly printers, must present copy which is not only readable but pleasing and acceptable to the eye.

The installing of a computing system can have a very material effect on staff. Very seldom is it possible to foresee accurately the staff savings resulting from the installation of a computing system, and where these have been estimated in the past they have tended to be on the optimistic side.

It is extremely doubtful if any modern organisation would wish to dismiss staff as a result of installing a computing system. The tendency would be to transfer them to other departments to replace natural wastage through retirement and resignations. Quite apart from the normal factors involved, any organisation which resorted to wholesale staff dismissals would, in this age of organised trade unionism, find itself in serious difficulties.

Nevertheless, when calculating the cost factors of installing a computing system, it becomes necessary to attempt to make some estimates concerning staff. It is usually possible to be fairly accurate in cases where keyboard operations are involved, and new requirements of punch or keyboard operators can be fairly accurately estimated and can be related to existing conditions.

LEO II computer installed in Cadby Hall. In the foreground is shown the control panel and in the right-hand corner, the various peripheral devices

Operators at the controls of a typical ZEBRA installation

Needless to say, when using computers, not as much basic information requires to be punched as previously, because much of this file type information can be stored, usually on magnetic tape, and made readily available to the computer when it is carrying out its processing.

To generalise in any field is dangerous, and to generalise with computers can be extremely so. Nevertheless it is necessary to do so to a limited extent in an article of this type.

One might perhaps say, therefore, that possibly the best approach to installing a computing system for commercial work would be first of all to ascertain precisely the requirements for the efficient conduct of the organisation concerned, and then to consider any additional work it might be desirable to perform beyond what is considered desirable at present, or what is even possible at present. Even then, the additional or even present requirements must be re-examined to see if they are really necessary. It might be advantageous to consider how these requirements could be dealt with by means of a computing system, remembering that a sequence of events might at this stage be more economically carried out by drastically reversing the present existing sequences.

The next step would be to consider the volumes of information involved, the time cycles and the number of staff at present engaged on the work or who would have to be additionally engaged to deal with any proposed additional work.

At this stage the individual tasks would have to be related and integrated, so that the final product of one becomes the raw product of the other. Seldom can any real saving be achieved without integration.

Having reached this stage one might justifiably and hopefully examine what equipment was available, which could be used, as originally envisaged, and which was capable of improving upon the present economics of the work.

In the next article we will consider a fictitious company which manufactures motor cars, and consider in some detail how this company might conceivably think of changing over to a computing system, to deal with its production control requirements, in the first place.

HEAT SEEKING INSTRUMENTS

FOR GUIDED MISSILES

Complexity of Interception Problem

GUIDED missiles can be launched from the air, the land, the surface of water, and from under water; each of these four classes can be directed towards a target, moving or stationary, in any one of the four mediums mentioned, giving sixteen variants in basic design requirements. This article is concerned with guided missiles used against moving targets in the air, irrespective of their launching position. The targets likely to be encountered in the air will range from conventional aircraft, flying at speeds of Mach 1 and upwards, to other missiles launched from high flying aircraft. Some of these missiles will, after release from the parent machine, rise to an altitude of 800 miles above the surface of the earth, and descend with a terminal velocity of 10,000 m.p.h.

Against such missiles, once they are into their stride, there is at the moment no known defence; but some of the principles embodied in short range defence missiles can be employed in long range missiles, adapted for either attack or defence. This gives a fair opportunity to attack high flying aircraft, even though some hundreds of miles away, before they launch any missiles which they carry. But granted the question of range is solved, there remains the problem of actual interception in the sense of making direct contact, and it is here that heat seeking instruments will play a very large part in the defences of the future.

Hitherto, the difficulty of final interception of aircraft flying at Mach 1 or above depended almost entirely upon calculations of course and speed; but the variation between theory and practice proved most disappointing. In theory, a missile could strike an aircraft at right angles, while each was moving at 600 m.p.h.; in practice, however carefully the calculations were made, interception always seemed to be missed at the critical moment. Instruments were then devised to be carried in the missile which would work out a future angle for interception, turn the missile away from a direct line of approach, and allow it to avoid undue acceleration at the last instant, while gradually closing in on the aircraft, which it finally hit, or was supposed to hit, at a tangent. Again, theory proved better than practice.

Three Categories of Instrument

Attention next turned to the possibility of "homing" on the target itself, irrespective of its movement, by utilising the heat an aircraft creates in flight. There were three lines of approach; firstly, what is called the passive approach. This method visualises highly sensitive directional detectors, operating servo controls within the guided missile, picking up heat waves, electromagnetic waves, or the noise waves from an aircraft. This conception includes detecting the aerodynamic radiation caused by the heating of a fast-moving body as it passes through the atmosphere.

Secondly, there is the semi-active approach. The defence forces on the ground employ a powerful radar transmitter rather as an old-fashioned search-light was used. The guided missile would then be able to "home" on the radiation reflected from the target after it had come within the scope of the radar transmission. This idea is usually referred to as the "Lamp-Set" method, and the radar gear can also be airborne under certain circumstances.

Finally, there is the active homing method, whereby the missile sends out searching radar impulses of its own, at the moment of rather short range, infra-red being about 10 miles maximum at nights. Using an appropriate frame of reference, the missile is able to determine its own position in space, subsequently following a pre-determined course to the target, the co-ordinates of which have been fixed in the "memory" of the missile.

Incidental Factors

Apart from having to withstand high acceleration shocks, especially at take-off and during violent changes of course both horizontally and vertically, the missile designed to use heat seeking instruments for final interception requires other equally specialised instruments as partners in its work. Two of these related items are sufficiently interesting in themselves to warrant brief mention. There is a directional gyro available, weighing only 5½ lb, whose inner axis enjoys a gimbal freedom of 85 degrees, while the outer axis freedom is unlimited. Its induction motor requires a running current of 0·1 amp, or less than 6 W of power. It can operate through a temperature range of from −55°C to +70°C. Ambient pressure is from zero to two atmospheres, and the instrument, under test conditions, has successfully withstood shocks up to 30 G. It can be stored without risk of deterioration for 60 months.

Another vital piece of equipment is the latest silicon rectifier of unlimited life, operating up to 200°C. A special method of treatment at very high temperature

enables certain vapours to deposit minute quantities of impurities in the crystalline structure of the silicon, thus forming a p-n junction. Two rectifiers linked together, and mounted on a cooling fin, provide more than 20 amp of direct current at 100 volts. (This may be said to equal some 2,000 watts, less 20 watts heat loss.) Fitted with a small silicon wafer, 0·005 in. thick and 0·1 in. square, each rectifier gives 5,000 times more current than normal rectifiers of a corresponding size.

Infra-red Detectors

Returning to the heat seeking instruments, these are required to respond to considerably less than one-twentieth part of a billionth of a watt of radiation. Detectors incorporating a photoconductor, and utilising germanium, work quite well at −320°C. (Basically, the ability of germanium to conduct electricity alters appreciably when its surface is struck by infra-red radiation. As such intensity changes are in direct ratio to the variations in the infra-red radiation, when they reach the photoconductor they may be there counted in the form of changes in electrical current flow.)

However, ordinary germanium is still not entirely ideal for the purpose; so that which is used in heat seeking instruments is dipped in gold in order to increase its sensitivity, and allow it to respond to longer infra-red wavelengths. It is unfortunate, perhaps, that the longer wavelengths, corresponding to i.r. temperatures, while being the most desirable are also the most difficult to deal with.

The latest germanium type detector has to be highly sensitive to 10 micron wavelengths, which is considerably faster (about ten times faster) than any other photoconductor detector. Developed by the Westinghouse Research Laboratories, this heat seeking instrument is provided with a mechanically-operated chopper which chops up the infra-red pulses into sections of only a few billionths of a second duration. Reflected to the surface of the detector, these pulses show a time that is consistent to two-tenths of a millionth of a second. The detector is cooled by means of liquid nitrogen.

Infra-red Domes

Considerable progress has recently been made in another important direction connected with heat seeking instruments. The Servo Corporation, working at New Hyde Park, Long Island, on behalf of the United States Navy, has made the largest one-piece infra-red dome so far produced. Already delivered to the U.S. Naval Air Development Centre at Johnsville, this 12 in. hemispherical arsenic trisulphide dome is being employed to test several different types of both ground and airborne infra-red detectors. It is sometimes carried by aircraft above a ground target, and sometimes flown suspended outside a high altitude plane. It is capable of transmitting to 12 microns, and covers the range from the near to the far infra-red region. Constructed of glass, this dome is impervious to deterioration through use, is non-hygroscopic and non-photosensitive. Under heavy pressure, the dome retains its shape without distortion.

The Related Problem of Fuel

As more and more heat seeking instruments go into service with more and more types of guided missiles, the performance of the missiles under the stresses of directional control must be constantly improved to keep pace with the additional needs thrust upon them during the final moments before contacting their targets.

Successful contacts have been made at ranges of several hundreds of miles, against test aircraft flying at great heights. In order to raise the average success of all missiles to the same standard as the best so far attained, and what is equally important in defence, also to allow the storage of the weapons without risk of deterioration against instant need over long periods of time, new fuels are being sought.

So far, the substitution of nitrogen-tetroxide for LOX answers the storage problem for 'ready-to-fire-instantly' weapons, while switching RP for acohol, and using the hydrazines for increased performance, promises increased chances of final and successful interception for the average missile using active homing heat seeking methods.

NEW INSTRUMENTS

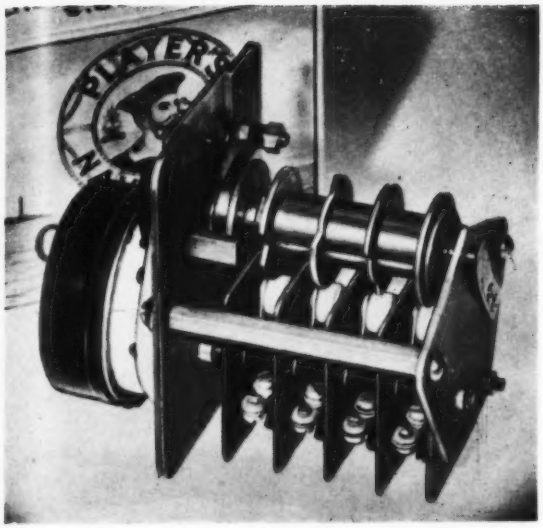
AT THE ELECTRICAL ENGINEERS' EXHIBITION

The eighth Electrical Engineers' Exhibition, held at Earl's Court from 17th to 21st March, featured more than 400 exhibitors, including about 50 companies which were exhibiting for the first time.

This year marks the Jubilee Year of the Illuminating Engineering Society and special attention was focused on the subject of display lighting techniques.

Brief descriptions are given of some of the new instruments shown at the exhibition.

D. Robinson and Co. showed a miniature multi-cam timer which can have up to eight cam-operated switches and can either revolve continuously or reset automatically on mains failure or disconnection. The Mark 2 version of the Type P3 sub-miniature relay which was shown has a shock-proof knife-edged armature pivot, ceramic insulation and provision for double-wound coils and adjustment of the fall-off point. It can be supplied sealed or with very low



Miniature multi-circuit timer (D. Robinson and Co.)

capacity contacts. Plug-in relays are now made for the "C. & S." system with mercury switches or magnetic blow-outs enabling the switching of d.c. mains and very inductive loads.

The temperature controller, Type TC.58, shown by **Radiovisor Parent Ltd.,** is designed to maintain temperatures at a preset level. The temperature sensitive element is a thermistor which is mounted in one arm of a bridge. A variable resistor is used in another arm of the bridge for setting the level of control. The bridge is fed from a transformer winding and the out-of-balance voltage is amplified and fed into the grid of a thyratron. Depending on the phase of this out-of-balance voltage being correct, the relay is operated when the temperature reaches its preset value; the contacts open when the value of the out-of-balance voltage drops. The accuracy is better than ± 1°C. The upper limit at which the thermistor can be used is 550°F but should higher temperatures than this be required platinum elements can be used. The response time is in the region of 200 milliseconds from ambient to full temperature limit. This temperature controller was originally designed for use in the polythene converting industry as was a static eliminator unit of alternating current type, which was also on view.

The latest models of the 'Transidyne' transistorised packaged Ward-Leonard adjustable speed drives were shown by **Lancashire Dynamo Electronic Products Ltd.** In these equipments transistors control the field excitation of the generator feeding the armature of the adjustable speed motor. The control circuits are also transistorised and are carried on a standard plug-in circuit board. Other examples of industrial electronic control equipment included a new range of counting units utilising alternatively photo-electric inductive or capacitative means of detecting the objects to be counted.

A pipeline "Dionic" conductivity cell was one of the new instruments exhibited by **Eversheds and Vignoles Ltd.** This conductivity cell is primarily designed for industrial applications, for example, the maintenance of the strength of cleaning solutions for bottle washing plants, or for monitoring the treated water from ion exchange plants. It permits the continuous testing of water without the need for withdrawing a sample, and it may be removed for cleaning or examination without requiring the plant to be shut down. The unit incorporates a thermistor to effect automatic temperature correction.

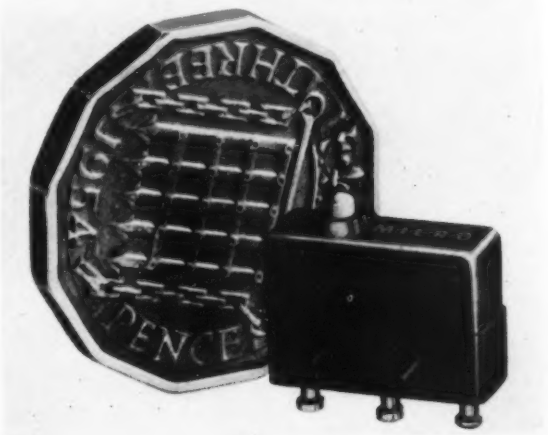
Elliott Bros. (London) Ltd. exhibited a low frequency generator and a reluctance motor for creep speed control such as raising and lowering control rods in a nuclear reactor. The motor would be situated inside the standpipe and would operate a winch. The motor-rotor has no windings; the stator is wound 3-phase, the supply for which is taken from the commutator of a d.c. generator driven at constant speed. When the control rod is to be moved, the brushes on the commutator of the generator are turned. In practice this brush gear would be operated by an electric motor having variable speed control and would move in either direction according to whether the control rod has to be raised or lowered.

The miniature cam-operated timer, Type AMS, shown by **Electrical Remote Control Co. Ltd.,** can operate up to 12 independent timing circuits with continuously repeating or single timing cycles of 30 seconds to 28 days. This company also exhibited a miniature automatic timer, Type AMS, controlling up to three changeover circuits with independent time settings, and an automatic time clock.

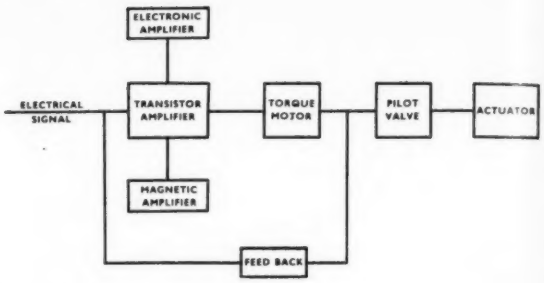
The sub-sub-miniature micro switch shown by **Honeywell Controls Ltd.** measures 0·5 × 0·35 × 0·2 in. The contact action is single pole, double throw, and the switch can be wired normally open or normally closed. Special plug-in limit switches for high-speed production lines designed for replacement within 20 seconds were also shown.

Equipment developed primarily for aircraft and weapons have in many cases useful industrial applications. This was demonstrated by **Sir W. G.Armstrong Whitworth Aircraft Ltd.** who displayed telemetry sampling techniques applied to general instrumentation.

Sub-sub-miniature micro switch (Honeywell Controls Ltd.)



Typical transducer layout showing the transducer connected between its control amplifier and an output valve



NEW PRODUCTS FROM WODEN TRANSFORMER CO. LTD.

This company, whose products are associated with the successful Black Knight project, recently demonstrated a new range of high-speed relays, torque motors, and patchboard units.

Wire Contact Relay

The basic unit is a 4-pole changeover plug-in relay with interchangeable twin wire contacts, 6- and 12-pole versions are also available. The moving contacts are silver alloy spring wire with a resistance of less than 0·05 ohms. The fixed contacts are silver alloy. The units and all fixed contacts are in a single piece moulding of high dielectric strength urea type powder. The contact operating block is moulded of wear-resistant urea formaldehyde, directly on to the armature, thus eliminating the intermediate wearing surfaces. The coils are wound on nylon bobbins and can be supplied completely sealed with acetone impregnated silk acetate or vacuum impregnated with tropical varnish.

Coil resistances from 100 to 10,000 ohms in operating voltages from 6 to 180 volts d.c. are available.

The relays are suitable for use in maximum ambient temperatures of 50°C. The unit has an expected contact life of three million operations which can be extended by the use of quenching circuits or by use at lower ratings.

The contact rating is: 0·5 A resistive 40 V d.c.; 0·2 A inductive 40 V d.c.; 150 mA inductive 160 V d.c.; and 100 mA resistive 250 V a.c.

The capacitance between poles is 2 μμF. The design of the relay is such that high-speed operation is obtainable with operating and release times down to three milliseconds.

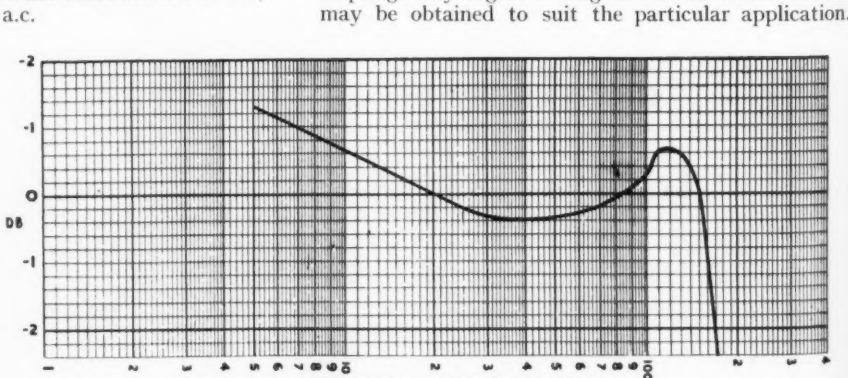
The dimensions of the 4-pole unit are $1\frac{3}{4} \times \frac{5}{8} \times 1\frac{1}{2}$ inches; of the 6-pole unit $1\frac{3}{4} \times \frac{7}{8} \times 1\frac{3}{4}$ inches. The small size of the unit makes it applicable for use in electronic equipment particularly in computer and video switching circuits.

Operating data of typical relays

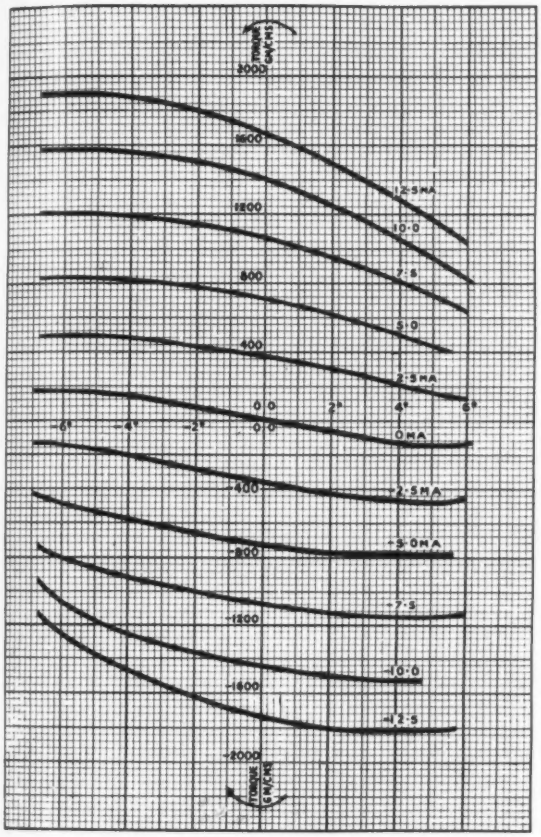
Number of poles	4	4	6
Coil resistance (20°C)	170	720	1,000
Operating voltage	10	40	40
Pull in current (mA)	36	18	16
Drop out current (mA)	10	9	8
Operating time (m secs)	5	5	5
Release time (m secs)	3	3	3
Temperature rise after 1 hr. (max.)	10°C	30°C	20°C

Torque Motors

Torque motors are electro-magnetic transducers consisting of a permanent magnet system with an armature which is moved by the passage of current through the control windings. The action may be differential or otherwise, depending on the coil connections. In a single ended system the transducers can be operated against a spring. Any degree of magnetic or electrical stiffness may be obtained to suit the particular application.



Frequency characteristics of torque motor Mark TM12 with windings in parallel and constant current



Torque output characteristics in single ended operation. For push-pull operation the torque is halved

In the Mark TM12 torque motor the stiffness factor of the armature relay is 0·196 lb ft/radian.

The device is usually used as an actuator converter between electronic, servo or magnetic amplifiers and hydraulic, pneumatic or direct mechanical linkages. An example of a typical application is as a torque converter between a push-pull or single-ended output stage of an electronic servo amplifier and a hydraulic pilot valve.

Feed-back windings or potentiometers can be incorporated. The transducers can be operated completely immersed in oil or provision can be made for fitting oil seals to prevent ingress of synthetic fluids which may have a deleterious effect upon the performance.

Where conversion of electrical signals into mechanical energy is necessary, the sensitivity of the units is such that a few milliamps of differential current can control large amounts of torque output from other devices. In the Mark TM12 torque motor the torque constant of the relay is 10·2 lb ft/amp.

Linear performance and fast rate of response in conventional servo loops are obtained, and the units have shown a wide range of performance in the automation, missile and machine tool industries. The torque motor has been tested to 70 G and found to operate satisfactorily.

Performance data of Mark TM12

Standard coil resistance	10,000 ohms or 70 ohms
Inductance of windings, 10,000 ohms	not less than 10 H
Inductance of windings, 70 ohms	not less than 50 mH at 750 cycles
Insulation	20 megohms at 500 volts d.c.
Flash test	1,000 volts, 50 cycles a.c. between windings and poles
Angular movement	approximately 7° either side of natural centre
Deflection current (Full torque)	not more than 10 milliamps for 1,300 gm/cms
Deflection current (Zero torque)	not more than 1·6 milliamps for 7° movement
Dead sector	not more than 4% of full deflection.

Patchboard Unit

The plugs of the patchboard system are small and the whole patchboard system in standard form occupies little space. Individual panels can be stored away for future usage after being set up for any given operation. Because of the barrel type plug there is no danger of upsetting by handling or during storage.

The removable front panel enables any number of used programmes to be stored ready for instant use.

Individual patch cords of any length are available in either individual, double, multi-ended or pick-a-back form, thus enabling a multiplicity of connections to be made.

A standard patchboard is 7 × 4 inches with a total of 334 sockets at $\frac{1}{4}$ in. pitch, both ways having 23 rows of 14 sockets with a single row of 12.

Each individual self-aligning spring-loaded contact has a positive lock.

Customer-built units in any form are readily available, based on the same concept.

The main feature of the barrel plug is that it is easy to plug in and easy to pull out, but almost impossible to push out. This ensures that accidental upsetting of the programmed system cannot occur during storage or use.

The patchboard finds application in aircraft control, machine tool planning, computers, test and demonstration rigs, process control equipment, etc. For instance, in certain machine tool control programming, the removable patchboard can be preset for any individual machining sequence of operations, this information then being coded and stored for future use against requirements of the same part.

The materials used in the construction of the units are generally in accordance with current Ministry specifications.

The contact pressure is 12-14 oz, each contact being silver plated as standard and gold plated to customers' requirements.

Maximum continuous current rating per contact is 1 amp. At the rated current there is a 10 millivolt drop.

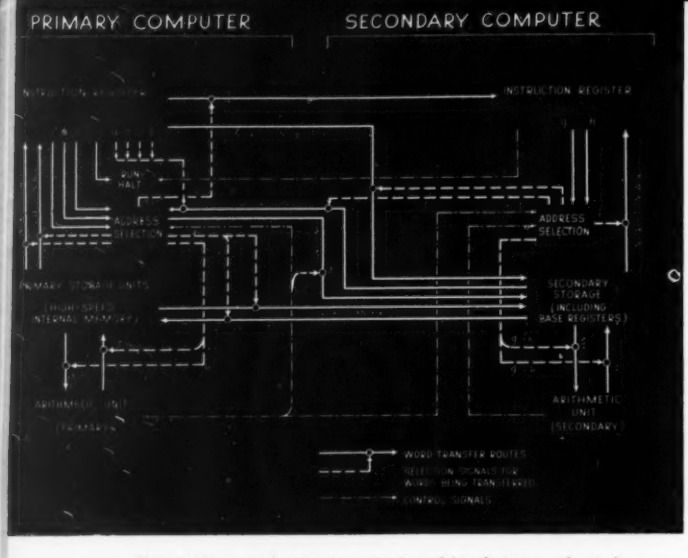


Fig. 1. Functional inter-relationships between the primary and secondary computers in a two machine network

One approach to the problem of developing more powerful computing systems is that of connecting together several computers into an integrated network. Techniques have been under study at the National Bureau of Standards for attacking and solving the logical problems encountered in organising such a network. These problems include devising a scheme for making all the computers collaborate efficiently, and designing an instruction system for carrying out such collaborative operations effectively.

ORGANISING A NETWORK OF COMPUTERS

THE National Bureau of Standards has been investigating the logical problems arising when several high-speed electronic computers are connected together to work on a common large-scale task. In organising such a network, many logical problems are encountered that do not ordinarily occur in the usual single-computer system. One problem is that of devising an efficient scheme for enabling all the computers to share among themselves, automatically, the total workload undertaken by the network. Another problem is that of designing a machine instruction system which can carry out these complex operations effectively and yet is simple enough to code easily. Techniques for attacking and solving these problems were investigated by A. L. Leiner, W. A. Notz, J. L. Smith, and A. Weinberger, of the Bureau's data-processing systems laboratory. One significant result has been the design of the new NBS Pilot data processor, a multi-computer network with powerful data-processing capabilities.[1]

Many large-scale data-processing jobs, for which solutions are now urgently required, call for much faster computing capabilities than presently available machines can provide. The resulting demand for computer components of higher basic speed has in many respects exceeded the resources of the current component technology. As a consequence, in order to shorten problem-solving times, it became necessary to try to organise these components into more powerful logical combinations for doing the job. One mode of approach is to connect together several computers into an integrated network so that all of the machines in the network could be made to work together on large-scale tasks. By dividing up the total task into different pieces, and by having all the different computers in the system work on different pieces of the task simultaneously, an increase in the speed of solution can be achieved.

Under ideal circumstances, the entire job could be split up into pieces that are completely independent, and each computer could carry out its assigned portion of the work without interacting on the other machines in the network. In actual practice, however, this ideal of complete independence cannot be attained because the results of one set of computations will, as a rule, be needed as input data for another set, and the starting of one phase of operations will have to wait for the ending of another phase. When these successive phases are carried out by several different computers, one machine may have to stop and wait idly for data from another if the different steps are not properly coordinated—thereby wasting time. The amount of productive time that might be lost in this way had to be evaluated before an efficient network system could be designed. It was found that queuing-theory techniques could be applied to evaluating such losses and to devising optimum schemes for making the computers in the network share a common workload.

Model Networks and Their Operation

In the theoretical investigation undertaken by the Bureau to evaluate the operation of multi-computer networks, a simple model network containing two computers was set up. In this model a primary computer shares its workload with a secondary computer connected to it via transmission lines (Fig. 1). Three types of communication between the machines are possible: (1) outgoing data from the primary to the secondary, (2) incoming data from the secondary, and

(3) control signals between the secondary and the primary. The distinction between primary and secondary computer is based on the rules by which the initiative for carrying out interchanges between the two machines is assigned.

Although both types are considered as independent internally programmed computers, the primary is the one that initiates the joint transactions between the two. The primary transmits a job request from time to time to the secondary to carry out some specific job. The secondary then starts immediately to carry out the indicated job, while the primary continues working, performing computations that do not need the result of data currently being worked on by the secondary.

The sequence of events for the most elementary type of system would be as follows. At the beginning, the primary initiates a request to the secondary. Some time later, the secondary finishes its job, halts, and sends a "job completed" notice back to the primary. At this time, however, the primary may not be at a stage in its programme where it wishes to accept the offered data. A delay ensues, during which the primary continues to run while the secondary remains idle, waiting for further orders from the primary. As soon as the primary reaches a suitable point in its programme, it issues a "call-back" order to the secondary and then immediately accepts the data that is returned to it. After its results have been accepted, the secondary remains idle until the primary transmits another request to it. This 3-phase cycle of (1) job-request, (2) job-completed notice, and (3) call-back order, continues until the data-processing task is completed.

This simple model is a fair approximation to some practical task-sharing applications. As a rule, though, certain further complications need to be taken into account. These complications arise when the nature of the task is such that the primary programme cannot be formulated so as to schedule its job requests to the secondary far enough in advance. As a result, it may not always be possible for the primary to be kept busy doing useful work during the time the secondary is working. The primary may issue its call-back order prematurely—that is, before the secondary has finished its job—and therefore the primary may have to stop and remain idle until the secondary can respond to the call-back order. One computer or the other, then, may sometimes be forced to wait, but both machines are never halted simultaneously.

The model can be further improved by providing for the primary to transmit more than one request to the secondary without intervening call-backs. However, the ability to store several job requests in the secondary, for that computer to work on concurrently, introduces a new complication: because the storage capacity of the secondary is necessarily limited, the person who programmes the task must not let the primary issue more than a certain number of job requests in succession (which load the secondary storage) without also issuing some intervening call-backs (which unload the storage). If this rule is ignored, at some point in the programme the secondary must halt without accepting new data until some of its previously calculated results are removed by the primary; the primary must also halt because it cannot proceed with its programme to possible future call-back orders without first disposing of its current request. Thus, a mutual deadlock occurs that cannot be resolved without outside intervention. Hence, the need exists for observing a programme convention that recognises some specific upper bound on the cumulative excess of requests over call-backs. This deadlock is not in any way dependent on computer speed or timing relationships but is entirely a function of the storage capacity of the secondary computer.[2]

Instruction System for Multi-computer Network

The network concepts discussed above have been incorporated into the design of the new NBS multi-computer system. This system is made up of several independently operating units that run concurrently. From time to time, as the need arises, they can exchange data and instructions.

The primary computer of this system is a full-scale machine that performs a wide variety of arithmetical and other operations. The secondary computer, though an independent internally-programmed machine, is more limited in scope and is intended mainly as an adjunct to the first machine. While the primary is performing the major arithmetical processing manipulations, the secondary concurrently carries out specialised procedures that assist the primary's programme, such as keeping tallies, counting iterations, modifying the addresses of the operands and instructions referred to by the primary programme, monitoring the primary programme, and various other special jobs. These correspond to the "job requests" delegated by the primary, mentioned above. Through the use of special sub-routines for the secondary, both computers acting as a team can carry out a wide variety of complex operations without unduly complicating the writing of the primary computer programme.

Associated with the secondary computer is the secondary storage unit containing a certain number of short word-storage locations. Some of these locations are used as "base registers" by the primary computer. These base registers contain numbers used by the primary as automatic address modification constants, or as alternative addresses for its next instruction. Loading of the base registers and manipulation of the numbers stored in them are carried out by the secondary computer.

To make a "job request", the primary instruction programme inserts a new instruction in the secondary computer's instruction register. Alternatively, the primary programme can also order data transferred between the primary storage unit and the secondary storage unit. By these means the primary is able to exercise unconditional control over the actions of the secondary programme. On the other hand, the secondary can influence the programme of the primary by manipulating the address numbers of the memory locations to which the primary refers.

To synchronise the actions of the two computers properly, the programming system earmarks certain selected instructions in the primary programme. Instructions so marked are intended to be performed after certain key instructions have been carried out by the secondary computer. They correspond to the "call-backs" discussed above. When an earmarked instruction

is reached in the primary programme, control of the relative time sequencing of primary and secondary operations passes to the secondary programme. This programme can then regulate the relative priority of execution of subsequent instructions in either programme by means of a special sequence-regulating instruction called an *rp* (regulate primary programme) instruction.

In operation, the primary computer, upon reaching an earmarked instruction, will check, before executing this instruction, to see whether the secondary computer is stopped and waiting with an *rp* instruction. If this is not the case, the primary waits until the secondary reaches an *rp*. As soon as both programmes have reached a mutual waiting status (that is, with the primary waiting with an unexecuted earmarked instruction and the secondary waiting with an unexecuted *rp* instruction), the sequencing will take place according to an explicit code written in the secondary (*rp*) instruction word. Various alternatives are available, under which priority may be accorded to either computer depending on whatever order of sequencing is most appropriate to the logic of interchange. Possible sequences include repetition or skipping of the primary instructions.

When both computers are in a mutual waiting condition, the secondary computer can also refer to the various base registers and control counters that the primary computer has just referred to or is about to refer to. The secondary computer can make these references either directly, that is, as a result of explicit register numbers written in the secondary instruction, or indirectly, that is, according to the locations specified in the currently waiting primary instruction. In consequence, the secondary computer can be used to monitor or interpret the programme of the primary in a highly flexible fashion.

The new NBS Pilot data processor contains not only a primary and secondary computer but also a third independent computer, which specialises in operations that control and interpret the data flowing between the system's internal memory and its external storage and display devices. In the future development of these network systems, it is expected that even larger numbers of independent machines will participate co-operatively in the performance of stringent tasks. Such systems will inevitably be more loosely organised with respect to centralised control than the relatively compact and self-contained machines of today. The dynamics of such loosely organised systems can probably be more effectively conceived of in terms of the group behaviour of large numbers of independent units, randomly interacting, rather than as an individual completely pre-scheduled machine process. As such behaviour can best be analysed in statistical terms, the problems of system design will increasingly become statistically oriented problems.[2]

Pilot Data Processor

The Pilot data processor will be utilised to simulate realistically a large number of different kinds of data processing systems. In this way the proper class of equipment characteristics suitable to the needs of each particular agency can be selected. In the event that the problem calls for novel performance characteristics not within the scope of existing equipment, the data processor will be used as an exploratory tool to provide a realistic basis for specifying what new equipment is needed. To be fully effective in supporting such a programme of investigations, the Pilot must be unusually flexible in its organisation and design and be at least as powerful as the machines it may have to simulate.

The logical design of the Pilot has therefore had to provide for exploring a wide range of applications. These include (1) business-type data processing applications, where the system performs accounting, record keeping, and information retrieval operations for management purposes; (2) scientific data reduction applications, where the system performs complicated mathematical and logical manipulations on the data; (3) control applications, where the system is used for real-time control and simulation operations in conjunction with analogue computer facilities or with automatic instrumentation facilities remotely located if necessary; and (4) data processing network applications, where the system communicates with other digital computer facilities to form a communication network in which all the computers collaborate on large-scale problems that are beyond the capacity of any one machine. In general, the Pilot will explore problem areas that could lead to improved management procedures, reduced operating costs, and increased efficiency and economy in data handling operations.

Because capabilities for investigating all these problems have been incorporated into the system's logical design, the Pilot will have a number of features not ordinarily associated with a single installation. For example, it will have extremely flexible controls for communicating with the outside world, and can freely exchange information with human operators or with a variety of data-collecting instruments. The Pilot will have a wide range of internal processing formats. These "built-in" formats will save time in programming problems. It will also have a high internal data manipulation rate. This high speed is the result of carefully balanced logical design rather than a simple increase in the basic digital repetition rate.

The Pilot system contains three independently programmed computers, each specially adapted for performing certain classes of operations that frequently occur in large-scale data processing applications. These computers intercommunicate in a way that permits all three of them to work together concurrently on the solution of a common problem. By such concurrent operation, it is possible to shorten the time required for solving large-scale problems. With this triple-computer system, a further advantage in problem-solving efficiency can be obtained by having each computer work on the portion of the problem for which it is individually best suited.

Of its three individual computers, the primary and secondary machines each utilise only 16 basic instructions (i.e., add, subtract, multiply, shift, compare, etc.), thus providing a simple code structure. However, because so many variations of the word format are provided, a wide variety of operations can be performed with these few instructions. Both primary and secondary computers, acting co-operatively, will be able to carry out special complex sorting or search operations.

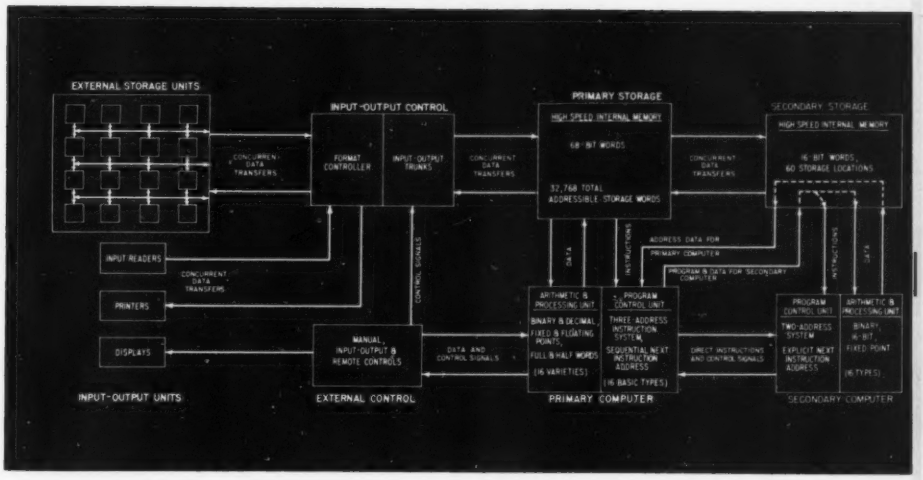


Fig. 2. Block diagram for the Pilot data processor under construction at the N.B.S.

The third computer in the system, called the input-output format controller, will specialise in editing, inspecting, and modifying information that is flowing into or out of the system. All three computers, as well as all the external units of the system, will share common access to the high-speed internal memory, which is linked to the input and external storage units via a number of independent trunks for effecting data transfers. The system will be able to transfer data concurrently along these input-output trunks, although only two are planned for the initial installation. Using two such trunks, it will be possible to maintain two continuous streams of data, flowing simultaneously between any two external units and the internal memory, without interrupting the data processing programme.

The Pilot system has been designed to operate with a wide variety of input-output devices, both digital and analogue, that are located either near or remote from the system. The external control capabilities of the system will enable the Pilot to supervise this wide family of external devices and, on an unscheduled basis, to interrupt or redirect its overall programme automatically in order to assist or manage them. Such impromptu interchanges of information between the system and devices or people external to it will occur at the instigation of either the external world or the Pilot, or both acting jointly.

As a result of the logical design the Pilot data processor should operate at fully comparable or better speeds than most modern large-scale commercial computers. The arithmetic speed derives in large part from connecting a novel type of parallel adder[3] to a diode-capacitor[4] memory capable of providing one random access per microsecond.

The system is built up of eight major blocks (Fig. 2): (1) the primary computer; (2) the primary storage; (3) the secondary computer; (4) the secondary storage; (5) the input-output control; (6) the external storage; (7) the input-output units, such as readers, printers, and displays; and (8) the external control containing the special features that facilitate communication with human operators and with devices external to the system.

While the input-output equipment in the initial installation has been kept to a minimum, provision has been made in the system for future annexation of a wide range of additional equipment to meet special requirements in solving certain problems. It will be feasible to annex such equipment without making significant changes in the existing system, primarily because of the flexibility of the format controller. This device is designed to accept input-output information from a number of different media and in a wide variety of information formats.

Arithmetic Operation Times

(including four random access times to fast memory)

Operation	Total time (microseconds)		
	Average	Min.	Max.
Fixed-point addition, subtraction, comparison ...	7·5	6	9
Fixed-point multiplication	31	22	40
Fixed-point division ...	73	72	74
Floating-point addition, subtraction*	20	19	21
Floating-point multiplication	37	28	46

* For shift of 4 bits.

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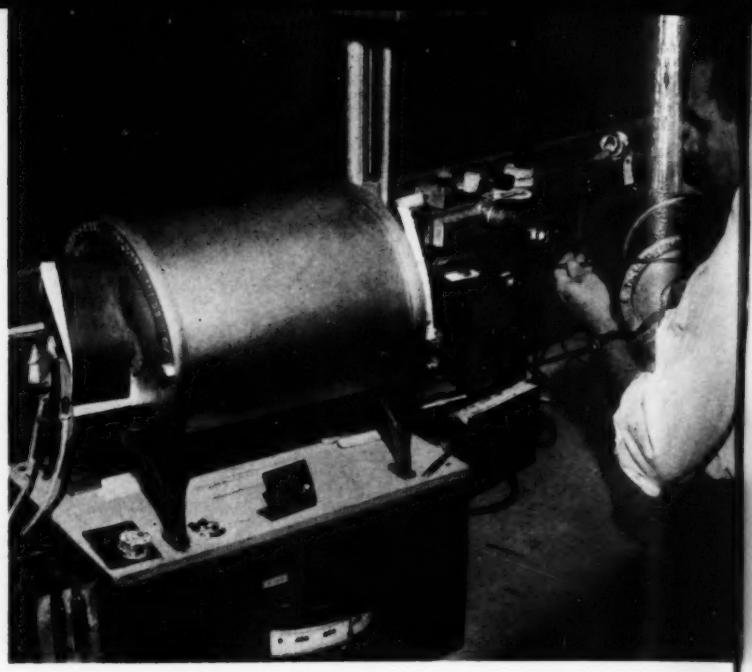
(3) A high-speed parallel adder. *N.B.S. Tech. News Bull.*, **40,** June, 1956, p. 77. *See also* A high-speed multiplier for electronic computers, *N.B.S. Tech. News Bull.*, **42,** April, 1958, p. 58.

(4) A diode-capacitor memory for high-speed electronic computers. *N.B.S. Tech. News Bull.*, **37,** Nov., 1953, p. 171.



Diffusing recombination centres into a slice of silicon to control the reverse recovery time for the completed diodes

NEW SEMICONDUCTOR DEVICES

Scientists working at the Bell Telephone Laboratories in the United States have recently developed several new semiconductor devices, such as a diffused silicon diode, a high current silicon switching transistor, and a family of high frequency diffused germanium transistors.

Diffused Silicon Diode

The new diffused silicon diode exhibits a recovery time as short as 0·02 microsecond. Typical forward voltage drop is 0·75 volts at 100 mA. Ampere currents may be handled on a pulse basis in a miniature package and steady state ampere currents in larger units. The diode is particularly useful for switching applications, including magnetic core circuitry. Zero bias capacitance is less than 25 μF, breakdown greater than 100 volts, and saturation current at 40 volts is less than 0·1 μA at 25°C.

Solid state diffusion techniques are employed to form the junction and to provide the proper recombination centre distribution to control the reverse recovery time characteristic. The wafers are sealed in a vacuum tight can and baked at 300°C or higher in a high vacuum to insure stability.

Switching Transistor

The new switching transistor is an n-p-n silicon unit with a diffused base and diffused emitter for high current, high-speed applications such as switching magnetic memories.

The new transistor is designed to operate as a switch at the 3/4 ampere level. At this level, the large signal current gain is 20 and saturation voltage drop 4 volts. The rise, storage and fall times are each of the order of 0·1 microsecond, and the alpha cut-off frequency is greater than 50 Mc/s.

High Frequency Diffused Transistors

The new small diffused germanium transistors act as millimicrosecond switches and 100-500 Mc/s oscillators and amplifiers. Objectives are transistors having high gain at high frequencies, reliability, low cost and small size.

HARWELL REACTOR SCHOOL

Second Course on Control and Instrumentation

A second course on the Control and Instrumentation of Reactors will be held at the Harwell Reactor School from 7th to 17th July, 1959, inclusive, and will be open to British and overseas students.

The course is primarily intended for those who have direct interest in the control and instrumentation of nuclear reactors, and it will be assumed that participants have some knowledge of the basic principles of these subjects.

The topics to be treated will include:—Revision of elementary reactor kinetics, control and instrumentation; automatic control of reactors and nuclear power plants; application of computers; reactor transfer functions and function analysers; neutron flux scanning; radiation detectors and their siting in reactors; reactor safety circuits; conventional instrumentation; use of transistors in reactor instrumentation; burst slug detection; spatial instabilities in reactors, and data reduction problems on large reactors.

In addition to the lectures there will be visits to zero energy and high flux research reactors and other relevant parts of the Harwell Establishment.

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* *Completely portable*
* *Built-in galvanometer and batteries*
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* *Fitted with the new 6001 switches*

Cat. No. 7383

Total range 0.0001 to 1 megohm.
Series Arm comprises four decades in steps of hundreds, tens, units and tenths of ohms.
Two Ratio Arms, 1, 10, 100 and 1000 ohms.
Manganin coils.

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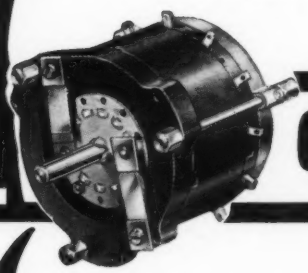
Total range 0.001 to 10 megohms.
Series Arm comprises four decades in steps of thousands, hundreds, tens and units of ohms. Two Ratio Arms, 1, 10, 100, and 1000 ohms. Manganin coils.

For measurement of extreme values of resistance connection can be made to an external battery and galvanometer. Extra terminals allow for the compensation of residual or lead resistances and such operations as the Varley Loop Test can also be carried out. The Series Arm decades can be used as a resistance box.

20,000,000. Operations



Pye Four Decade Resistance Box
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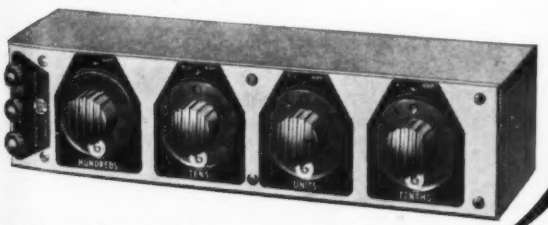
Novel presentation gives the reading in line, appropriate figures showing clearly against the contrasting background. The accuracy is ±0.02%, except "tenths" decades which are ±0.2%. Manganin coils are fitted. The decade box is constructed to have low thermal e.m.f. low-reactance winding and is mounted in a stove-enamelled grey-blue case: details of a.c. performance are given in a descriptive leaflet, available on request. Three models now in production.



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* *Remarkable repeatability*

6001 PYE LOW RESISTANCE PRECISION INSTRUMENT SWITCH

* *Overall Switch Resistance: 0.7 m Ω*
* *Variation of Contact Resistance: ± 20 μΩ*
* *Contact Resistance Drift during life of switch: ± 50 μΩ*
* *Thermal e.m.f: 0.008 μV per degree Centigrade with uniform change of temperature*

During a life test the new Pye instrument switch completed 20 million operations, which is equivalent to some forty years of service. Yet the switch remained virtually unchanged—in fact, the stability improved within the rather narrow range specified! No maintenance was required and test conditions were more severe than usual.

Send for full details of this switch and the instruments in which it is incorporated.

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ACCURATE DIGITAL DISPLAY

The problem of unsteady readings on conventional meters, or errors due to misinterpretation and parallax are entirely solved by the clear presentation achieved in this new series of transistorised instruments. Characters displayed are over an inch in height and unmistakably clear even at a distance, owing to the high efficiency of the optical projection system incorporated. There is thus no possible ambiguity of reading.

The LM901 Solartron Digital Voltmeter is one of a range of digital type instruments available shortly. This range includes the LM902 with a range of 0 to 159·9 volts; TM923—a five window instrument of 159·99V full scale for computing use, and LM904 with automatic ranging from 1·599V to 1599·9V. All these instruments have facilities for remote indication of the digital values displayed and may therefore be used as accurate analogue-to-digital converters.

BRIEF SPECIFICATION OF '999' DIGITAL VOLTMETER TYPE LM901

Voltage ranges:	0 to 0·999V; 0 to 9·99V; 0 to 99·9V.
Range extension:	An 'add 10' button extends the digital count to 1099.
Input impedance:	1 megohm; 100 kilohms on 0·999V range.
Accuracy of indication:	Absolute 0·25% long term. Short term 0·1%.
Reading time:	280 milliseconds for any change of indication.
Polarity & decimal display:	Both the polarity and decimal point position are clearly displayed.
Printing output:	Coded decimal output is provided.

INSTRUMENT Practice
AUTOMATION & ELECTRONICS

SURVEY OF NEW INSTRUMENTS

ELECTRICAL · ELECTRONIC · MECHANICAL · NUCLEONIC · PNEUMATIC

Vitramon Capacitors

A NEW range of Vitramon capacitors has been made available by The Plessey Company Limited especially for use in radio and electronic equipment where close tolerances and negligible capacitance drift are vital factors.

Vitramon porcelain dielectric is a controlled material, lending itself to the production of capacitors with electrical and mechanical characteristics not possible with such natural materials as mica.

Two ratings are available in the new range, at 300 voltage drop continuous working and 500 voltage drop continuous working. The capacitors are also capable of withstanding 200% of rated voltage to provide complete insulation.

Close tolerances are maintained without drift by the capacitors over considerable periods of time; standard tolerances being $\pm 5\%$ or 0·25 μF, whichever is greater. For more rigid requirements, special orders can be filled for tolerances to $\pm 1\%$ or 0·1 μF, whichever is greater.

A noise level of less than 10 microvolts is guaranteed with the new Vitramon capacitors, further, humidity has no effect on the impervious vitreous material, which maintains its insulation resistance after total immersion or 100% humidity and repeated temperature cycling.

Circle **1** *for further details.*

Flame-trap Ancillary Unit

UNDER present practice, a flame-trap is provided to arrest the flame temporarily in the event of a blow-back. However, unless it is noticed, the blow-back flame will ultimately burn through the flame-trap.

Now, with the added protection of this new unit, which introduces a detector in front of the element of the flame-trap, gas can be shut off, or an alarm given, within a fraction of a second of a blow-back occurring.

This unit, known as the Ether flame-trap ancillary unit, Type 350, is small, compact and very reasonably priced. It is readily adaptable to all existing flame-traps. Special features include a "broken-detector" device which puts the unit in a "fail-safe" condition in the event of a detector element break. A press-button reset is incorporated to ensure that, after a blow-back has been eliminated, the controlling valve or safety circuit will not re-open until it is reset manually. A small neon lamp lights up when the unit is in the alarm position.

The unit is suitable for wall or panel mounting and takes a 230 volt, single phase supply.

Circle **2** *for further details.*

High Stability, Wide Range A.F. Oscillator Type RCO.59

THIS instrument is a general purpose, variable frequency signal source with good initial calibration accuracy, high stability with regard to changes of temperature and mains supply voltage. The output is balanced and of low distortion.

The instrument is a resistance capacitance tuned oscillator employing an inverse feed-back circuit. The frequency determining network is a Wien Bridge. The amplitude of oscillation is held constant by means of a thermistor. A buffer amplifier is used between the oscillator section and the level control to minimise reaction to the oscillator frequency.

The output amplifier is designed to provide a balanced output of 600 ohms, other impedances can be supplied to order.

The capacitive elements of the bridge are controlled by a main frequency dial, and the resistive elements are selected by means of a range switch.

Frequency range: 30 cycles—30,000 cycles in 3 ranges. Each range covers a decade (30-300 cycles, 300-3,000 cycles, and 3,000-30,000 cycles), continuously variable.

Frequency control: The main control dial is engraved from 300-3,000 cycles. A 3-position switch multiplies the scale frequencies by 0·1, 1·0 and 10.

Frequency calibration: Each instrument is adjusted within $\pm 1\%$ or 1 cycle, whichever is the greater.

Frequency stability: The warm-up drift is less than 0·1% or 1 cycle, whichever is the greater, after 30 minutes.

Output impedance: A single balanced output of 600 ohms is provided.

Output attenuator: This is variable by means of a 6-position selector switch and includes the range +20 dB to −30 dB (reference 1 milliwatt).

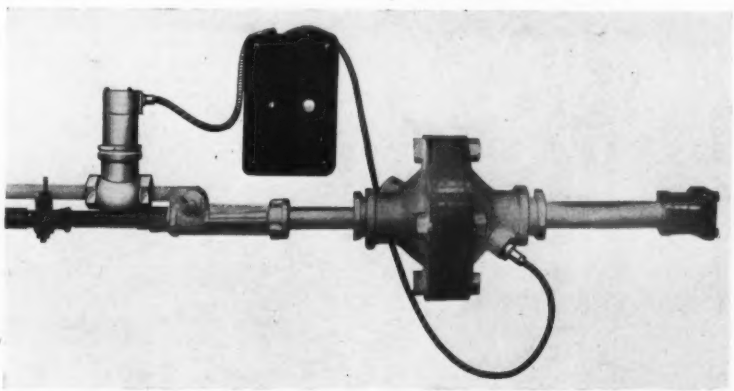
Harmonic content and noise: The total harmonic and noise output is less than 2% over the full frequency range.

Power supplies: The equipment is suitable for operation on 100/130 V, 50 cycles or 60 cycles mains, or 200/250 V, 50 cycles mains.

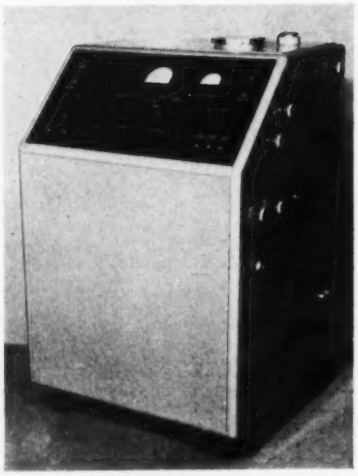
Circle **3** *for further details.*

Mass Spectrometer Leak Detector

BY employing the mass spectrometer tuned for a particular probing gas, the leaks in a sealed system can be detected easily at comparatively high pressures with extremely high sensitivity. The technique is applicable to both vacuum and pressure vessels. The mass spectrometer leak detector is a completely self-contained, portable instrument which consists of a vacuum system of high pumping speed in which are incorporated the mass spectrometer system in addition to an ionisation gauge and Pirani gauge. The system is so designed that components can be directly pumped and leak tested on the apparatus; the combination of Pirani gauge, ionisation gauge and mass spectrometer covering the range of leaks from tens of lusecs to 10^{-7} lusecs.



Flame trap ancillary unit



Mass spectrometer leak detector

The mass spectrometer unit consists of a miniature 180° mass spectrometer which can be tuned to mass numbers up to 40. The sensitivity of this device is highest at the lowest mass numbers and the use of hydrogen and helium as the probe gases gives the highest sensitivity.

Using hydrogen, leaks of the order of 10^{-6} lusecs can be detected, whilst with helium 10^{-7} lusecs is the minimum detectable leak rate of the mass spectrometer ion current.

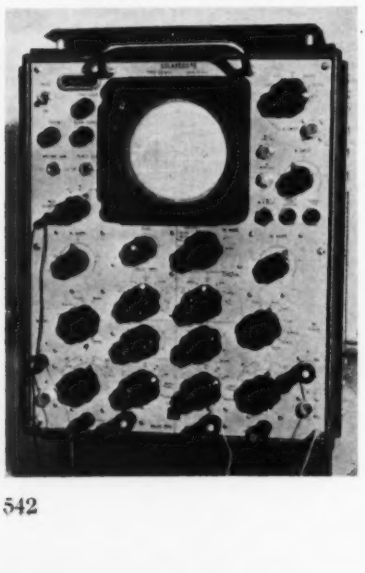
In addition to meter indication a loudspeaker is fitted which emits an audio note, the pitch of which is related to the magnitude of the ionisation current. This facility enables the operator to carry out tests on components from positions which would prevent the direct observation of the meter indication.

The only external connections which are required for the instrument are electricity services and water supply. This instrument is now in regular production.

Circle **4** *for further details.*

Infinite Persistence Oscilloscope

THE infinite persistence oscilloscope Type QD.910 employs a "Memotron" storage cathode ray tube which gives an infinite trace persistence. The trace is immediately erasable after each investigation is completed.



Infinite persistence oscilloscope, Type QD.910

The QD.910 is a dual-channel instrument, each channel having a bandwidth of d.c. to 1 Mc/s.

The instrument has provision for external brilliance ("Z") modulation of the time base waveforms and delay pulses are brought out on the front panel. An internally-generated waveform provides automatic erasing for initial setting of the tube controls, such as focus, shift, etc.

The "sampling" mode of operation is extremely important. In this, the time-base makes one stroke, and the resultant trace is stored for any period up to 100 seconds. The trace is then automatically erased and this sequence repeated continuously. This mode of operation is particularly useful for locating a particular piece of information stored, for example, on magnetic tape.

The writing-gun current is automatically adjusted according to the velocity of the spot to produce storage at high writing speeds without excessive beam current at low writing speeds. This ensures a uniform picture brilliance for all types of work.

Circle **5** *for further details.*

Mallory NO-CHAT

JOHNSON MATTHEY & CO. LIMITED announce that they are now producing and marketing in Britain Mallory NO-CHAT, a sintered tool shank material possessing characteristics that have gained it wide acceptance in precision machining in the U.S.A.

NO-CHAT has a modulus of elasticity of 40×10^6 lb/in², a density of 16·96 g/cm³ (0·606 lb/in³), a coefficient of linear expansion (100—200°C) of 5×10^{-6}/°C together with an ultimate tensile strength of 112,000 lb/in².

Circle **6** *for further details.*

Electronic Thermometer L.T.100

THIS instrument was developed originally for measuring the exothermic temperature rise of resin castings. It is particularly suitable for measuring component temperatures, overheating of instruments, and thermal losses in solid and liquid systems.

A feature of the new thermometer is its ability to measure temperature at the end of a long cable. A prototype instrument, now being used for geological survey, allows for the probe to be used 1,000 ft below the earth's surface. The probe, embodying a temperature-sensitive metallic oxide bead, is connected by a moisture-sealed lead to a sensitive d.c. bridge measuring circuit (patent applied for). The probe has a very small heat capacity and the temperature reading, therefore, is practically instantaneous.

Because only a small amount of energy is required to power the probe, errors due to self-heating of the bead during operation of the thermometer are negligible.

There are two types of probe. The immersion probe is fitted with a glass-sealed head suitable for immersion in liquids or gases. The probe body is a chemical-resistant epoxide moulding composition which is sealed to a nylon covered lead. The contact probe has the oxide element sealed into the epoxide probe body, and a thin metallic cover acts as a thermal contact.

The small mass of the metal and the efficient thermal insulating properties of the epoxide body ensure rapid stabilisation of the contact. The thermal energy is still further conserved by the use of platinum-alloy leads, with a low Wiedemann-Franz ratio, for making electrical contact to the head.

Model available: L.T.100. 0 to 50°C and 50 to 100°C. Accuracy ± 1°C (2 ranges).

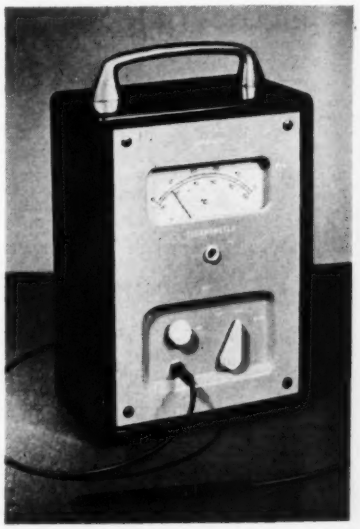
The instrument is battery operated. Under normal operating conditions, the expected life of the battery is at least six months.

Thermometers calibrated on °F can be supplied on request.

Further models are under development for measuring from −100°C.

Circle **7** *for further details.*

Electronic thermometer L.T.100



Improved Protective Paint

A, METAL coat that leaves a protective film of pure zinc when applied to steel surfaces has been improved by the addition of an extra binder.

This ensures a still harder surface and will make the paint more useful for things such as anchor chains, gas cylinders and anything else subject to abrasion and friction.

Also the carrier has been slightly changed. This makes no difference to the efficiency of the mix, but it enables the zinc to get into suspension more quickly—in other words, the paint is now easier to stir.

The product is known as Rust-Anode and is made by C. & P. Development Co. (London) Ltd. It can be applied by brushing, spraying or dipping. The resulting protective coat is strongly adherent, ageproof and rustproof.

A brush application of Rust-Anode deposits a 95% pure zinc coat of 0·002 in. thickness, which experiments have shown to be equivalent in rust inhibitive properties to a heavily galvanised surface.

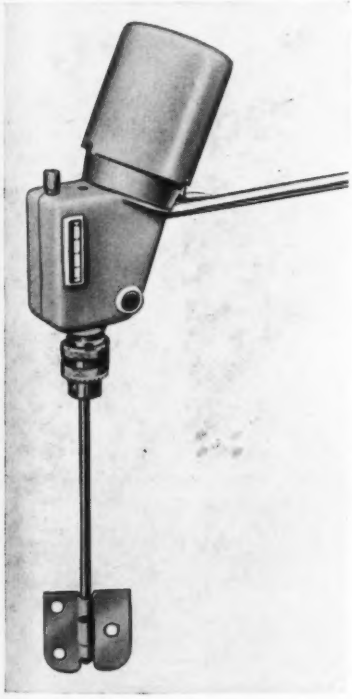
Application is simple and can be done on site without dismantling or the use of special equipment or skilled labour. It is only necessary to remove loose scale and powdered rust before application and to see that the surface is free from grease and moisture.

The coat is touch dry within 30 minutes, and sufficiently dry for further treatment within 24 hours. It is non-toxic and can be used with safety for food containers, fresh water tanks, etc.

Circle **8** *for further details.*

Type RZR Laboratory Stirrer

THE principal feature of the stirrer is that the infinitely variable drive gives full motor output over the entire speed range. On conventional type stirrers, torque is lost and speed reduced. Additionally, high



Type RZR laboratory stirrer

and low speed shafts, chromium-plated chuck and key, tubular shafts and powerful brushless motor are included in the standard equipment.

Circle **9** *for further details.*

D.C. Signal Source

THIS unit is a portable item of equipment and provides a d.c. signal of variable magnitude. It is invaluable in a laboratory where an accurate low-powered d.c. supply is required for such purposes as testing of amplifiers, transistors, transductors, relay operating current measurements, and a great number of other applications.

The unit gives a 0-50 V d.c. supply which may be used either as a voltage source or a current source.

When used as a voltage source the 0-50 V d.c. supply is metered with a high grade 0-50 micro ammeter used as a voltmeter and the metered output is then fed to an attenuator giving eight ranges of voltage on the range switch.

When used as a current source the 0-50 V d.c. supply is fed to the output terminals via the meter and the range switch shunts the meter and introduces a suitable limiting resistance in the output to prevent damage to the meter on each of the eight current ranges.

The unit is fitted with a reversing switch so that the polarity of the output may be reversed without having to disconnect the leads to the unit.

Circle **10** *for further details.*

Miniature Instruments

A NEW range of panel mounting 240° scale miniature instruments, with 2 in. and 2½ in. dials, is now available. The instruments have been developed specially for use in the electronics industry and should be of particular interest to firms making telecommunications equipment, measuring and test gear, and electronic process control gear.

The accuracy of the 2½ in. diameter instruments is ±1%.

The 240° scale gives scale lengths of 3½ in. and 4½ in., i.e., twice the scale length of 90-100° short scale instruments of similar dial diameter. Nine 3½ in. scale instruments can be mounted in a 6¾ in. square panel space.

From the design aspect, the small instruments follow the robust and rugged construction of the larger C.P. switchboard instruments and are a complete breakaway from the usual construction of instruments of this size. In consequence they can withstand electrical, mechanical and climatic stresses of a very high order.

The new instruments are available in either moulded plastic or sealed die-cast metal cases. Supplied in the metal case form, the instruments withstand the Admiralty 200G shock test.

Circle **11** *for further details.*

The England Finder

THE England finder is a glass slide marked over the top surface in such a way that a reference position can be deduced by direct reading, the relationship between the reference pattern and the locating edges being the same in all finders. The object of the finder is to give the microscopist an easy method of recording the position of a particular field of interest in a specimen mounted on a slide, so that the same position can be re-located using any other England finder on any microscope.

Circle **12** *for further details.*

Saturable Reactors as Stepless A.C. Power Controllers

FOR controlling a.c. circuits of high power such as those necessary in electric furnaces for the manufacture and heat-treatment of locomotive parts, saturable reactors have the important features of simplicity and long life. They benefit from the advantages inherent in amplifiers with saturable reactive elements when compared with electronic type amplifiers.

Fundamentally, a saturable reactor is a form of transformer with one winding connected between an a.c. supply and a load, and with the power delivered to the

Miniature panel mounting instrument

load controlled by a small amount of d.c. power flowing in another winding. Saturation achieved by the d.c. power is made possible by the omission of any air gap in the transformer core, so enabling the d.c. current to vary the a.c. permeability.

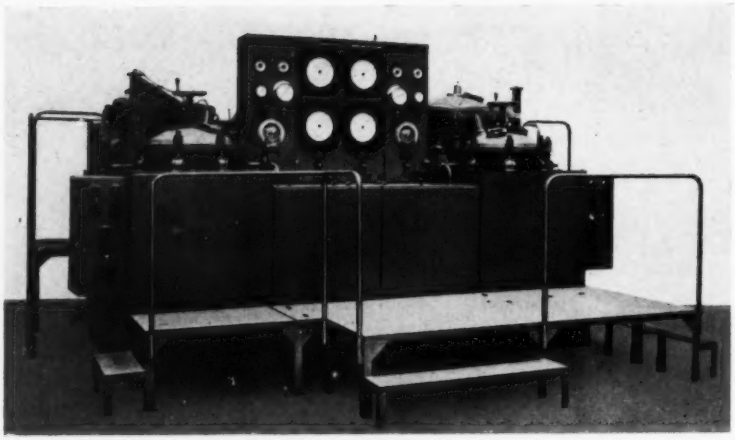
Haddon Transformers Limited are producing stepless a.c. circuit controllers ranging up to 100 kVA load capacity and, for use in cases where d.c. powers available are limited, magnetic amplifiers are included. A special non-linear device is applied where there is no d.c. power.

In addition to furnace control, typical applications are: servo mechanisms, a.c. voltage stabilisation, a.c. motors, control of air conditioning and heating systems, heavy-duty battery charging control, automation systems, plastic and plywood heating, signals control, computers and calculators.

The equipment under control is safeguarded as the method is purely electrical and there are no moving parts to develop mechanical faults. The amount of d.c. power required, for example, is claimed to be as little as 20 W to control the Haddon 10 kVA saturable reactor output from 3% to 91% of its full a.c. load. Similar characteristics are shown by both the smaller and the larger models of the range which includes open and closed types processed to suit any climatic conditions.

Circle **13** *for further details.*

Haddon saturable reactor, 2 kVA, 50 c/s, open type



"Hyvacoilfil" high vacuum hermetic sealing plant

High Vacuum Hermetic Sealing Plant

THE production of "C" core transformers and similar electrical components to up-to-date specifications necessitates high vacuum drying and impregnation in a modern plant specially designed and constructed for the purpose.

The "Hyvacoilfil" model illustrated is a duplex unit of compact design with two high vacuum impregnators at the front and a central control panel which houses vacuum and temperature recorders, gauges, etc. At the rear of each impregnator is a larger vacuum storage vessel which also serves for de-aeration and dehydration.

The impregnators are fitted with removable covers which swivel clear for overhead loading and unloading, and for other operations to be carried out on the oil.

The plant operates at a vacuum of 100 microns or below on both the electrical windings and the electrical insulating oil for impregnation and hermetic sealing.

It is fitted with a large capacity water-cooled high vacuum pump of the rotary oil sealed type with oil separator and gas ballast. This is mounted at the rear of the plant with other auxiliary equipment, control being effected from the front.

An important feature is the system of de-aeration, dehydration and filtration of the impregnating oil under vacuum to exclude all traces of air and moisture. This is carried out in the storage vessels which are fitted with cascade troughs, the oil being continuously circulated by means of a special pump and transferred to the impregnators and returned without breaking the vacuum.

The plant is electrically heated and thermostatically controlled at a constant pre-set temperature. Heating control panels which are mounted at each end of the plant include the necessary relays, switches and pilot light indicator to simplify operation.

Depending upon size, the plant is built up in one or more completely assembled and works-tested units, and is easily installed and transportable should factory layouts be altered.

Larger plants are also provided with platforms, as illustrated.

Single impregnator plants with the same general features are also available.

Circle **14** *for further details.*

Voltage Controller

THIS voltage controller has been designed as a compact and portable instrument providing an output voltage which may be varied from 0-270 volts a.c. when supplied from a 230 volt 50 c/s a.c. supply.

The instrument consists of a continuously variable transformer, the output of which is displayed on a high grade a.c. voltmeter.

The input and output circuits are fitted with fuses, and a pilot lamp and on/off switch are also provided.

The input is by means of a 6 ft flexible mains lead, and the output may be taken from either a 3-pin 5 amp socket or a pair of insulated terminals.

Circle **15** *for further details.*

"Reguplug" Controls Electrical Heating Apparatus

A PLUG to fit directly into 3-pin sockets and provide any piece of electrical heating apparatus with fully variable control from zero to full is now available.

Known as the "Reguplug" it incorporates the "Simmerstat" in either a 15A or 13A (fused) three-pin plug moulded in brown or white Bakelite. Amongst the possible uses suggested for the "Reguplug" are control of electric kettles, percolators, soldering irons, airing and drying cabinets, blankets, sterilisers and any item needing variable heat control.

Overall dimensions (excluding pins) are :—

13A plug $3\frac{1}{8}$ in. long × $2\frac{1}{16}$ in. wide × $2\frac{1}{2}$ in. deep.

15A plug $2\frac{7}{8}$ in. long × $2\frac{1}{16}$ in. wide × $2\frac{1}{2}$ in. deep.

Circle **16** *for further details.*

Transitrol with Proportional Temperature Control

THE Type 995 Transitrol, which has a 7 in. indicating scale, operates in conjunction with a proportioning motorised valve and affords proportional control, to very close accuracy, on gas or oil-firing applications. It can also maintain steam at a constant pressure under varying loads.

Temperature control is attained by the use of a conventional galvanometer as the measuring system. An indicator-pointer operates a simple photo-electric system which, in turn, controls the valve-positioning motor. The latter is powered by a 24 volt, 50 cycles, shaded-pole, reversing motor comprising two stators and two rotors, coaxially mounted on a common shaft which transmits power to the final drive shaft through a silent and accurately-machined gear train.

The entire instrument, which is suitable for wall or panel mounting, is designed as a plug-in unit and is easily withdrawn from its casing.

The proportional control and manual reset, featured in the Type 995, are also available on the Transitrol Type 994 programme controller, which indicates and controls temperature to a pre-determined time programme, and the motor linkage can be attached to any mechanism to which it is desired to add the refinement of proportional control.

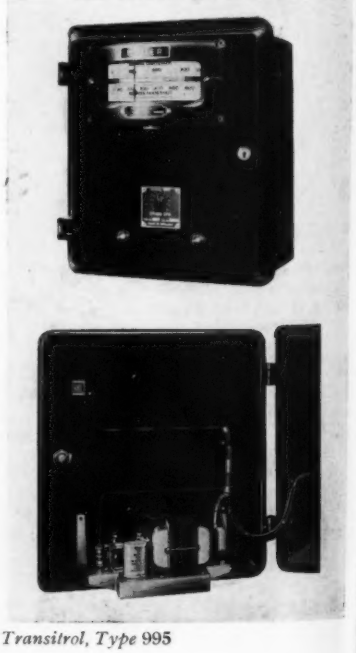
Circle **17** *for further details.*

Pressure Containers

ALFRED BULLOWS AND SONS LTD., Long Street, Walsall, have introduced two new centre top outlet pressure containers, specially designed for use with liquid polishing compounds and similar heavy materials.

These containers, which replace the conventional bottom outlet types, have been given the numbers L.1005H and L.1010H and have capacities of 5 and 10 gallons respectively.

Shells are constructed from mild steel boiler quality plate with dished and



Transitrol, Type 995

Pressure container with lid removed, showing outlet pipe and ram plate

flanged ends and are electrically welded throughout. Covers are high tensile aluminium alloy castings and are fitted with quick action filler caps.

In common with all Bullows pressure containers, they are built to B.S.S. 1101/1943 for a maximum working pressure of 50 p.s.i. and are hydraulically tested to 100 p.s.i.

Ram plates are fitted on both models as standard equipment. Agitator gear has been omitted since it is usually undesirable to stir the types of materials for which these containers would be used. Both units incorporate $\frac{3}{4}$ in. o.d. straight through feed pipes which have no bends or obstructions to impair the flow of material and discharge is from the centre of the container head. An outlet of $1\frac{1}{4}$ in. diameter is available as an alternative.

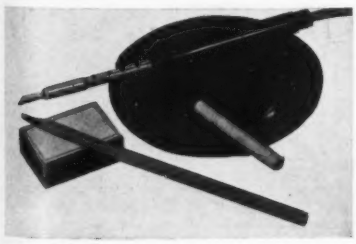
Outlet valves are not considered necessary when liquid polishing compounds are used, but if required for use with less viscous materials they are available at extra cost.

The price of the L.1005H is £27 10s. 0d. and the L.1010H costs £28 10s. 0d., both prices plus 20%. Delivery of both units is at present two to three weeks.

Circle **18** *for further details.*

Sub-miniature Soldering Iron Type SMS

SUB-MINIATURE soldering iron Type SMS can be used for continuous soldering of 60 amp copper lugs, direct soldering to 16G steel chassis and with lower element rating for mass production of television, radio and any other electronic or transistor assemblies.



Sub-miniature soldering iron

The alternative element ratings are 10W, 15W, 20W, 25W, 40W, 55W, and 75W. The weight of SMS soldering iron without cable, but with small copper bit, is approximately 1 oz. There is a choice of 20 standard types of exchangeable soldering bits with $\frac{1}{16}$ in. to $\frac{5}{16}$ in. diameter tips.

Circle **19** *for further details.*

"Remscope"—A Transient Storage Oscilloscope

PREVIOUS storage oscilloscopes made by Cawkell's have used the American "Memotron" cathode ray tube and their performance has been limited by the relatively slow response of that tube. Now, with the advent of the English Electric Type E702 storage and display tube, this limitation no longer applies and the "Remscope" has been designed to make the fullest use of the tube.

The E702 tube contains a storage system which allows a transient to be stored for up to a week and displayed for a limited period during that week. In the "Remscope" this display time (which may be taken piece-meal) exceeds 15 minutes and may, on all but the fastest signals, be extended to nearly two hours.

The persistence of the display can be varied from a few seconds up to 15 minutes. This facility is particularly useful when comparing one event from a series with its predecessor. By adjusting the persistence the first signal can be made to fade as the third appears and so on. Varying the setting will allow other sequences to be produced.

Erasure is rapid and may be obtained by depressing an internal press-button or making an external circuit. An external erase timer, allowing the signal to be removed after a pre-set interval, will be available.

Initially a single-channel wide-band Y amplifier with differential d.c. inputs will be fitted. To enable it to be replaced by different units in the future, this amplifier is of a plug-in type.

As the oscilloscope is intended primarily for the study of transient signals, great care has been taken to ensure reliable and easy triggering. A.C. or d.c. signals may be used to start the time-base and starting is automatic once the input potential exceeds a pre-set level.

The time-base covers a range of velocities from 3 cm/μ sec to 0·1 cm/sec and a 5 times expansion is possible by means of the X amplifier. The Y amplifier has a rise-time of 0·15 μ sec but is also provided with a high-gain narrow-band operating condition. Both amplifiers and the triggering circuits are direct-coupled throughout. Crystal-controlled time markers are provided for calibrating the time-base and they are clamped accurately to provide a voltage standard. The voltage measuring accuracy is $\pm 1\%$. Stabilised h.t. and heater supplies ensure the minimum of drift. A provisional price of £625 and delivery commencing in July is predicted.

Circle **20** *for further details.*

Printed Circuit Connectors

THE 15-way plug and socket is fitted with steel dowels. The contacts are on a 0·1 in. module.

Circle **21** *for further details.*

"Remscope"

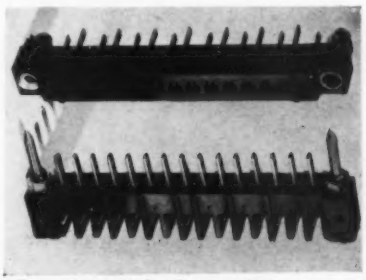
Graviner High Sensitivity Detector

THE Graviner high sensitivity detector applies the principle of oil mist detection to "sense" and locate a small degree of abnormal temperature rise on any of the main bearing and main working surfaces within the crankcase of a diesel, petrol, gas or dual-fuel engine.

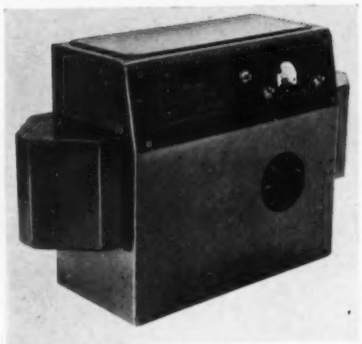
The Graviner detector measures the density of oil mist drawn continuously through two separate tubes of precisely similar dimensions. Projected down the axis of both tubes is a beam of light which energises two photo-electric cells situated at the ends of the tubes remote from the common light source.

The electrical output from each photocell is proportional to the density of the light falling on the surface of each cell, and as their output is opposed electrically no current flows when the oil mist column contained in the tubes is of equal density. However, when a difference occurs in the mist density contained in one tube relative to the other, the obscuration of the light beam is greater in that tube and, consequently, the system becomes electrically out of balance. A current then flows operating a sensitive relay which in turn causes an audible and visible warning to occur when the differential e.m.f. reaches an optimum value.

The apparatus is extremely simple to install and is connected to the engine by a number of flexible sampling pipes fitted with quick release couplings to corresponding connections mounted in the inspection door of each crank chamber.



15-way printed circuit connectors



Graviner high sensitivity detector

Two models are available. The standard a.c. model is suitable for connection direct to 230-250 a.c. 50-cycle mains supply. A d.c. model is available for connection to 220 d.c. mains via a separate external voltage dropping resistance unit. Equipment for connection to alternative electrical supplies can be made available.

Apart from the detection of over-heated rotating or reciprocating engine components, the high sensitivity detector will quickly "sense" a broken piston ring.

In addition, the extreme sensitivity provides positive protection against crankcase explosion by warning against generation of a dangerous concentration of oil mist within the crankcase.

The apparatus will operate for long periods with a minimum of maintenance. It is suitable for installation on all types of diesel, petrol and dual-fuel engines up to 500 h.p. per cylinder, either supercharged or normally aspirated, whether direct or controlled, up to a maximum of 3,000 h.p.

Circle **22** *for further details.*

Peak Voltmeter

In this 50 kV peak voltmeter for the measurement of single or repetitive pulses of 1 μ second duration or greater, the incoming pulse is applied to a voltage dividing capacitor network with a ratio of 50 : 1 and the voltage across the larger capacitor is measured by means of a 0-1 kV electrostatic meter. A level restoring diode shunts the meter to allow repetitive pulses to be measured. The indicated pulse slowly discharges through an insulation resistance of greater than 10^{15} ohms, the measuring circuit being hermetically sealed to maintain this figure. Discharge can be obtained by pressing a button on the front panel which operates a relay within the sealed compartment.

50 kV peak voltmeter

Two ranges are readily available, 10 kV to 50 kV and 5 kV to 25 kV. The accuracy of measurement is better than ±5% using calibration curves supplied showing initial calibration to irradiated sphere gap to B.S.358.

The weight of the instrument is approximately 15 lb and operates from 200-250 V, 50 c/s mains supply. The price is £175.

Circle **23** *for further details.*

FSP36

Johnson, Matthey and Co. Limited announce the development of a new thermo-setting silvering preparation that has been given the code name FSP36. The preparation is based on silver in the form of finely divided flake and is specifically designed to enable surface films of relatively high conductivity to be applied by spraying or brushing to such materials as plastics, ceramics, graphite and glass. Alternatively it may be used as a conducting cement. The only limitation on its application is that the material being coated must withstand heating to 100°C, the minimum temperature necessary for curing the organic vehicle that carries the silver.

The preparation has excellent covering power and the stoved film is hard and abrasion-resistant, with an electrical resistance in the range 0·2 to 2 ohms per square.

Circle **24** *for further details.*

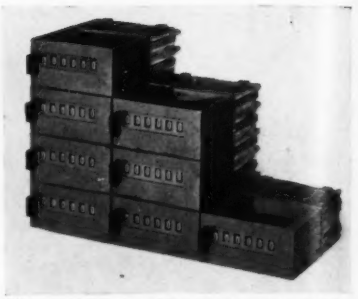
Hengstler Electromagnetic Counters

Lancashire Dynamo Electronic Products Ltd., of Rugeley, Staffordshire, have obtained the sole selling rights in Great Britain for the Hengstler electromagnetic counters Types F43 and F43M2.

These high-speed counters are already being widely incorporated in all forms of counting installation manufactured by Lancashire Dynamo Electronic Products Ltd., and they are also offered as component items for general industrial applications and are available in preferred coil ratings on an ex-stock basis from the company's Component Division

Capable of counting at speeds up to 2,400 impulses per minute and having an extremely long life expectancy, the Hengstler F43 and F43M2 units are basically similar in design, both providing six digit indication: the F43 incorporates manual reset and the F43M2 has both manual and electrical reset. Both types are available in high-speed or low-speed versions and at a number of preferred d.c. operating voltages. Rectifier units for operating at certain preferred a.c. ratings will also be available in the near future.

Lancashire Dynamo Electronic Products Ltd. wish to emphasise that the arrangements outlined above apply to the marketing of the Hengstler high-speed counters Types F43 and F43M2 only. Other mechanical and slow-speed electro-mechanical counters produced by J. Hengstler K.G. will continue to be marketed in this country through their agents, Brian R. Morris & Co. Ltd., 118 London Road, St. Albans, Herts.



F43 counter assembly showing interlocking arrangement

Circle **25** *for further details.*

Transistor Adaptors for R.F. Bridge B.601

There are four adaptors and a d.c. control unit. The latter is suitable for operation with each of the adaptors. They also measure all the parameters of usual interest to both the transistor designer and the application engineer.

Adaptor "A". Q.601.Y_{11} is used for measuring input admittance Y_{11} in the grounded-emitter configuration and with the output short-circuited. The accuracy of measurement up to 1 Mc/s is ±2%. At 5 Mc/s the error increases slightly but can be allowed for.

Adaptor "B". Q.601.Y_{11} is used to measure the input admittance in the grounded-base configuration with the output short-circuited. The accuracy of measurement up to half of the α cut-off frequency is to within ±2% in both resistive and reactive components. At cut-off frequency the error rises to about 3% in the reactive component only.

Adaptor "C". Q.601.Y_{22} is used in measuring output admittances Y_{22} in

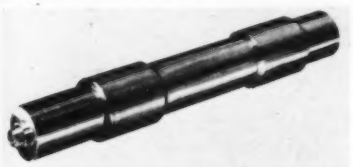
R.F. bridge B.601 with one of the adaptors in position on the top (centre). On the right are two microammeters measuring emitter current and collector voltage

grounded-base circuit with the input short-circuited. The error of measurement is less than 2% in both resistive and reactive components over the whole frequency range of the bridge.

Adaptor "D". Q.601α is used in measurement of grounded-base current gain α and the information can be used for plotting the phase diagram of the transistor. Accuracy of measurement is 2% provided the technique of measurement as detailed in the instruction booklet is followed. From the knowledge of α and Y_{11} the forward mutual conductance Y_{12} in the grounded-base configuration can be obtained. Similarly, the current gain in the grounded-emitter configuration αi can be obtained from the value of α.

D.C. Control Unit. Q.601. This unit supplies all the adaptors with the necessary d.c. voltages and currents. In addition, the unit is so designed as to safeguard the possible danger to transistor or electrolytic capacitors in certain types of measurement. Facility is provided to monitor the essential d.c. supplies of the transistor.

Circle **26** *for further details.*



*PX.*115 γ-*ray proportional counter*

γ-ray Proportional Counter Type PX.115

THE Type PX.115 is a high resolution proportional counter originally developed for the γ-ray spectrometer. The energy resolution of a proportional counter below 100 keV is better than that of a scintillation counter and its employment extends the range of scintillation γ-ray spectrometers to 20 keV.

The counter is 2½ in. in diameter with an overall length of 16 in. It has a gas filling of a mixture of highly purified xenon - methane at a pressure of 2 atmospheres absolute and the operating voltage range is between 3,500 and 4,200 volts. Measurements of the energy resolution have been made using an americium^{241} source which emits γ-rays of 59·4 keV. The best resolution which has so far been obtained with these counters is 5·6%. Over the operating range, the gas multiplication factor is 60 volts/dB.

Circle **27** *for further details.*

Metrawatt Transistorised Cable Tracer

THE Metrawatt transistorised cable tracer will locate immediately the exact position of buried cables. It will also indicate the position of open or short circuits in the wiring. A sensitive transistorised pocket-size amplifier detects either the voltage on the conductor or the current flowing when the instrument is placed in the vicinity of wiring under investigation. A meter indication is given or alternatively headphones can be plugged into the sockets provided.

The instrument can also be used to detect floor or wall heating elements,

Transistorised cable tracer

cables buried in plaster, walls, soil, etc., as well as for the detection of circuit faults.

It is completely portable, for it weighs only 7 oz and its size is 3 in. × 4 in. × 1 in. It is also virtually unbreakable with plastic case and shock-proof meter. The information it provides results in a marked reduction in time and cost in electrical installation and maintenance work. The price is £14 15s. 0d., with immediate delivery.

Circle **28** *for further details.*

Carpenter Polarised Relay Type 521

THE Type 521 Carpenter polarised relay is based on its predecessor, the Type 51, and incorporates several new features.

Used as a chopper at 50 c/s, virtually no change of adjustment should be necessary due to mechanical wear, within 2,500 hours; samples on test have already exceeded 10,000 hours with very little loss of adjustment.

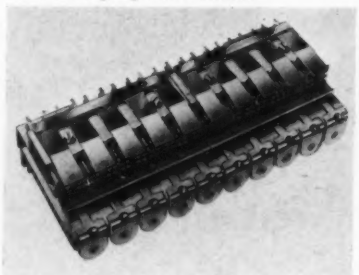
Used as a d.c. relay, great improvement in stability is achieved by a redesigned contact damping system employing a line contact in place of a point contact.

The Multiple Relay

The relay employs a common yoke integral with mounting brackets, and is intended to replace telephone type relays in control circuits where cost is of prime importance.

Contact springs of phosphor-bronze, with silver bi-metal contacts in the crossed radii technique, and automatic machine adjustment and card operation, ensure a constant contact pressure. An efficient magnetic circuit ensures that magnetic interaction between relays is virtually non-existent, while the common yoke mounting brackets greatly reduce the number of piece parts and eliminate the need for a separate mounting piece.

Circle **29** *for further details.*



10-*way multiple relay*

Shadomaster Minor 60

THE Minor 60 is now in production and has been on the market since April. It is a self-contained portable cabinet projector. The price is £80 complete with one lens.

The Minor 60 can be employed in either the vertical or horizontal position. Magnifications of 10× and 25× are obtained with interchangeable lenses. Additional accessories include second lens at £30; a work holding fixture at £7; the same style co-ordinate work-stage as used on the Shadomaster Junior at £35; vee-blocks, in one unit, with centres, at £12 10s. 0d.; and the standard K K surface illuminators Nos. 1 and 2 at £15 each, which are interchangeable with other models in the Shadomaster range. For use with the projector in the vertical position, a flat table is provided which is held horizontally in the vice of either the workholding fixture or the co-ordinate workstage. Into this table is fitted a glass insert upon which workpieces may be laid for projection. The price of this accessory is £4 10s. 0d.

Circle **30** *for further details.*

Shadomaster Minor 60

Two New Hivac Tubes

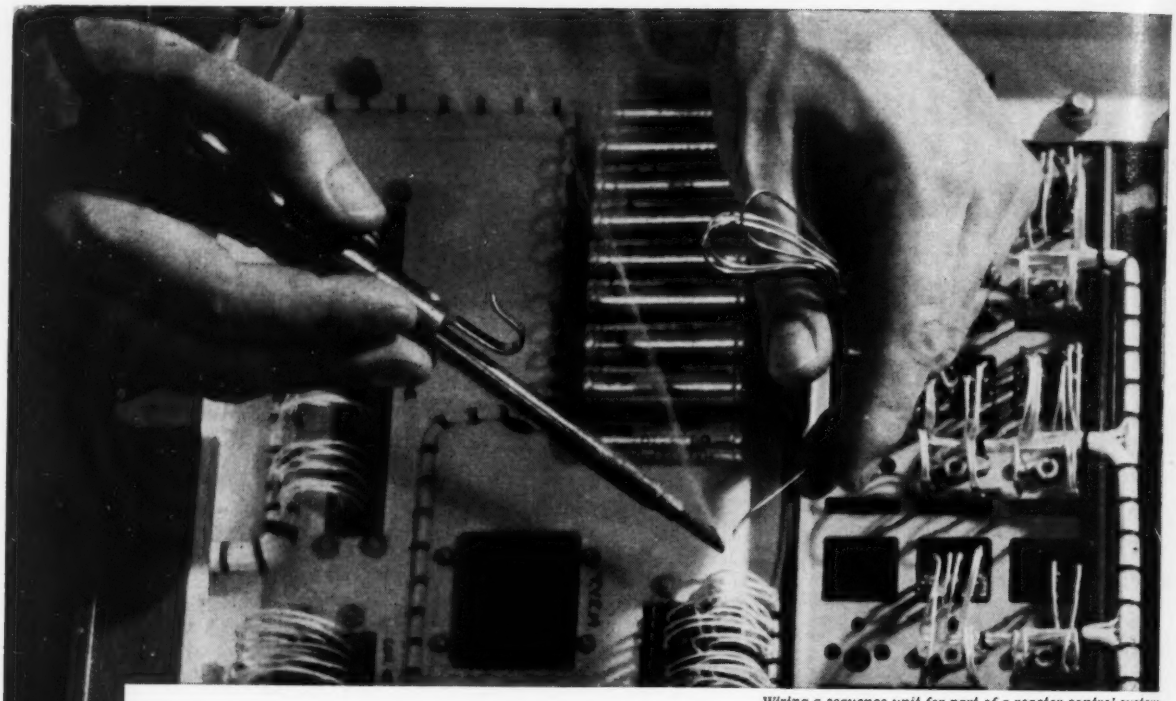
Two new sub-miniature tubes, the h.f. double triode XR9 and the twin trigger cathode tube XC24—have been added to the Hivac range.

The XR9 is a 6·3 V indirectly heated valve with characteristics similar to those of the American Type 6111. Apart from radio circuitry, the most important use of the XR9 is in counting or computing circuits where it can fulfil the functions of the much larger valves 12AU7 or 12AT7 which have previously been widely used in such applications.

The Hivac Type XC24 has been designed as an "or" gate and for use in forward/backward counting chains or similar circuits.

Circle **31** *for further details.*

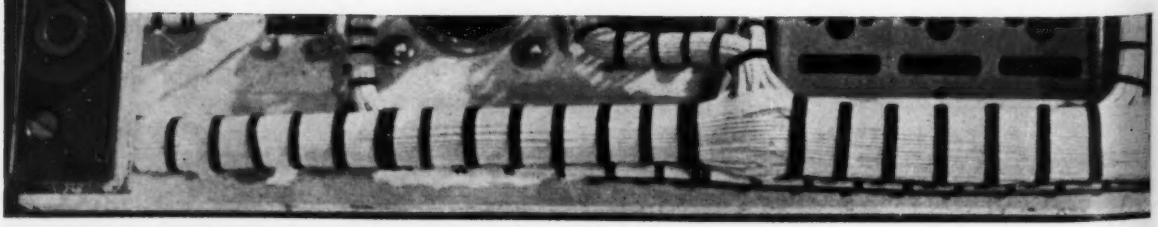
Circle 50 for further information

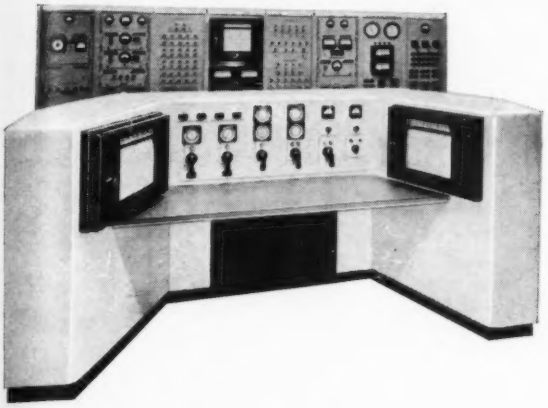


Wiring a sequence unit for part of a reactor control system

SUNVIC
–instrumental in Britain's industrial progress

Continuous improvement of instrumentation techniques is essential to progress in process control. Backed by the extensive research facilities available within A.E.I., Sunvic maintains an active policy of planned development. Sunvic introduced pneumatic force-balance instruments to this country in 1950 and has made notable contributions in other fields such as data handling and computing, reactor control systems and scientific instruments.





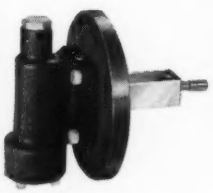
Complete systems

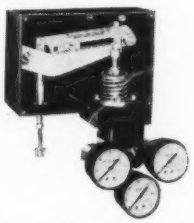
Equipment for research and power reactors includes instrumentation for boilers, steam and gas circuits; a range of instruments for reactor power level monitoring; safety, control and interlock circuitry and data handling systems for burst fuel cartridge detection. The illustration is of the control desk and panel for the MERLIN research reactor at A.E.I. Research Laboratories.

Pneumatics

Liquid level transmitter: weighs a displacer by true force-balance means; can also be used to measure specific gravity or interface level. Can be mounted on pipe tee or tank nozzle. Maximum static pressure 200 p.s.i. Ambient temperature limits: -40°F to +450°F.

Valve Positioner: available with either lever or turnbuckle connections (illustration is of latter type with cover removed to show easy adjustment). Proportional bands of 1%, 5% or 10%. Response: with 4% valve friction, output responds to 0.1% control air pressure change.

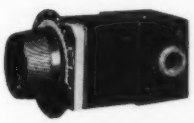


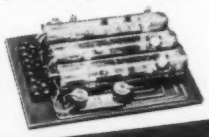


Components and electronic systems

Energy Regulators: available in several forms with a continuous rating of 1kW at 230V A.C. and up to 6kW at 230V A.C. when used with HVS relays.

HVS (Hotwire Vacuum Switch) Relays: for switching up to 17kW, 3-phase at 440V A.C. or 10kW at 440V D.C. use. No arcing; low non-inductive operating current.





Send for details

of Sunvic pneumatics, components or nuclear instrumentation to:

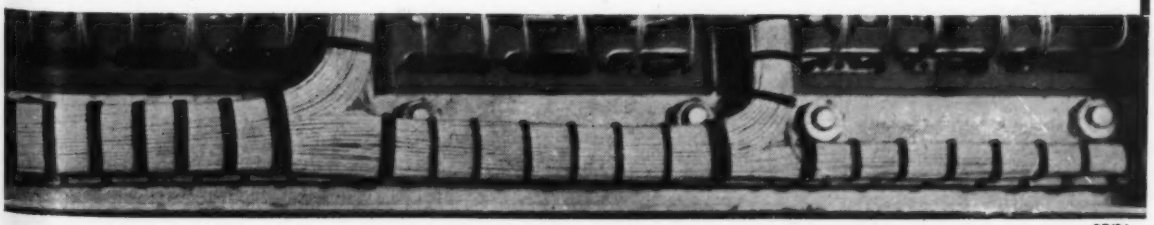
SUNVIC CONTROLS LTD

P.O. BOX 1, HARLOW, ESSEX.
TEL: HARLOW 25271

SUNVIC

An A.E.I. Company

Instruments and complete instrumentation



SC/184

Circle 51 for further information

Now **Kent-Barton** Mercuryless Instruments join the **Commander** range

Commander *Kent-Barton instruments, showing (cut-away) the patented Barton differential-pressure unit*

for wet gas

for corrosive fluid

for off-level mounting

Mercuryless differential-pressure instruments for flow and other variables are the latest addition to the wide KENT **Commander** range. These have certain advantages over the mercurial types wherever wet gas or corrosive fluid is to be measured or where level mounting is difficult or impracticable. Models available are either circular-chart recorders, sector-scale indicators (automatic control optional); or circular-scale indicators. Optional recording of Bourdon-tube pressure and/or mercury-in-steel temperature also available in addition to primary variable.

Commander mercuryless instruments incorporate the Barton patented differential-pressure unit. Although the actuating element is a sensitive bellows, pressure differences as high as the pressure rating of the instrument can be sustained without damage to this rupture-proof unit.

some features

Choice of six maximum differential pressures: 50 to 400 in. w.g.
Standard safe-working pressure: 2,500 lb/sq. in.
Controlling unit: KENT air-operated one-, two- or three-term **Mark 30** series within the instrument
Pressure elements: up to two Bourdon tubes for pressures 3,500 lb/sq. in. to 30 in. mercury vacuum
Temperature elements: mercury-in-steel with limits from −40°F/−40°C to 1100°F/600°C
Mounting: wall, panel or post
Write for Publication 354, or telephone General Industrial Contracts Department (Luton 2440, Ext. 8) for a quotation.

KENT

masters of instrumentation

GEORGE KENT LIMITED · LUTON · BEDFORDSHIRE · ENGLAND

Factories, Subsidiary Companies, and Branch Offices in London · Resolven · Hitchin · Toronto · Montreal · Vancouver · Melbourne · Sydney Johannesburg · Salisbury · Penang · Bangkok · Brussels · Krefeld · Vienna

NEWS OF THE INDUSTRY

International Transistor Exhibition and Convention—Admission Tickets

FINAL details for receiving Convention delegates and Exhibition visitors have now been resolved, and tickets for admission to the Exhibition are now available.

Applications for Exhibition tickets, whether from individuals, scientific bodies, engineering companies, government departments, or from universities, technical colleges and schools, may be sent to: Industrial & Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2.

Sunvic Mobile Exhibition Tour

A 35 foot long exhibition caravan with working demonstrations of pneumatic instruments made by Sunvic Controls Limited has been touring shipyards in this country. It has been fitted to show the application of Sunvic instruments to marine installations.

Demonstrations included a working mock auxiliary exhaust steam pressure control system arranged to show how pressure can be controlled to a high degree of accuracy for current practice.

Other demonstrations showed systems for automatic control of turbine lubricating oil temperature and furnace fuel oil temperatures.

The vehicle also carried a range of standard pneumatic instruments including some of especial interest to marine contractors. These included a relay which is particularly useful for continuous tank level indication since it requires no pumping or other adjustment, and a helium-filled temperature transmitter for remote indication of temperatures up to 1,000°F.

After the tour of this country, the vehicle went on a tour of Holland and Belgium.

British Standard for Conversion Factors and Tables (Basis of Tables; Conversion Factors) (B.S. 350 : Part 1 : 1959)

B.S.350, conversion factors and tables, is being revised, and a first part has now been published in a 114 page, fully indexed volume. The standard will be much enlarged in scope by its revision, and when this has been completed it will cover, broadly, units, their abbreviations, conversion factors and detailed conversion tables for a wide range of subjects falling under the general headings of metrology, mechanics and heat.

Part 1 gives extended basic information on units, together with the standard abbreviation for each unit or combination of units considered. A feature of the standard is the inclusion of comprehensive tables of conversion factors, showing the relationship between any two of the British and metric units used in the measurement of a given physical quantity. Summary tables of units and conversion factors are also included, together with an appendix on thicknesses of sheets and diameters of wires.

Part 2, which is now being prepared, will include a more extended range of tables than those in B.S.350 : 1944. A list of the detailed conversion tables allotted to Part 2 will be found in Part 1. When Part 2 is ready, the two parts will be available either separately or as a combined standard. In the meantime the detailed tables of the 1944 edition will still be serviceable, and are obtainable at the reduced price of 7s. 6d. per copy, but the other parts of that edition are now superseded by the new Part 1.

Difficulties due to the small differences between the British and U.S. legal yards, and likewise between the legal pounds, have been overcome by the use in B.S. 350 of common units of length and mass defined by means of the following relationships:

1 yard = 0·9144 metre

1 pound = 0·453 592 37 kilogramme.

These are the definitions adopted in 1959 by the National Standards Laboratories of Australia, Canada, New Zealand, South Africa, the United Kingdom, and the United States of America for use in science and technology.

Copies of this Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price: 15s. 0d. (Postage will be charged extra to non-subscribers.)

Carl Zeiss Instrument Show

DEGENHARDT & CO. LTD., the British agents of Carl Zeiss, recently exhibited a range of Carl Zeiss microscopes, photomicrographic apparatus and precision mechanical instruments obtainable in this country. Another exhibition, chiefly of refractometers and polarimeters, will be held in May.

Latest E.M.I. Equipment for New York I.R.E. Show

SOME of the latest products of E.M.I. Electronics Ltd. were exhibited for the first time in North America during the I.R.E. show in New York.

These included EMIAC II, the company's general-purpose analogue computer, which has been specially designed for use on guided weapons, nuclear reactors and other simulation problems.

Other exhibits included a new industrial stroboscope with the exceptionally high rate of 60,000 flashes per minute and a high light output. A photo-electric probe, photo-head amplifier and light diffuser are built in on this instrument. Also being shown was a bench balancing machine, developed for the dynamic balancing of small electric motor commutators.

Visitors to the exhibition were also able to see one of the latest additions to the E.M.I. range of oscilloscopes, the WM16. This instrument has been specially designed to meet the requirements of the North American markets and has several novel features including plug-in units which give it great versatility.

Industrial tubes and valves manufactured by the company's Valve Division were also shown. These include the latest klystrons, photomultipliers and magnetrons, together with cathode ray tubes and camera pick-up tubes.

Doran Instrument Factory

THE new factory of the Doran Instrument Co. Ltd., at Stroud, Gloucestershire, has now been completed and marks a further milestone in the successful progress of this company. It incorporates many of the modern improvements in factory design, and in particular under-floor electric heating installed by the Midlands Electricity Board.

A New Factory

MANUFACTURERS of welding electrodes and equipment, Rockweld Ltd. of Croydon, Surrey, are building a new factory at Camberley, Surrey.

Automation in Russia

A DEVELOPMENT from the plant performance recorder, the ideas for which were published by the British Iron and Steel Research Association only two years ago, is now being built in Battersea for instalment in a giant tyre factory in Russia. The factory is to be built by a consortium of British firms and the monitoring equipment is now being made by The Digital Engineering Co. Ltd., of 136 Battersea Park Road, London, S.W.11.

The factory is to be erected near Dneipropetrovsk and is designed for the production of large numbers of tyres for cars, lorries, tractors and heavy earth-moving equipment. The layout and operation is to be based on the latest ideas in automation.

The entire process of tyre and tube making is to be monitored hourly and at the end of each shift, providing the production manager with a complete classified summary of his production of the various components. This monitoring will be done by the BISRA equipment, which was originally seen as an aid in the manufacture of steel products, but clearly has many potential uses throughout industry generally.

Production figures will be obtained for the number of batches of rubber mixes,

the number of yards of fabric, the number of treads, tread parts, cured and uncured tyres, and cured and uncured inner tubes. Records will be obtained from 500 different machines.

All the counting equipment will be centralised and an adjacent office will be equipped with page printers, where the hourly and shift production totals will appear coded according to size or type.

Ketay Awarded M.O.S. Design Approval

KETAY LIMITED, manufacturers of synchros, resolvers, tachometer generators and other servo components, are now a Design Approved Manufacturer under the Ministry of Supply Instrument and Electrical Equipment Design Approval Scheme.

Four Ketay synchros have been granted certificates of technical approval following type testing to specifications approved by the Royal Aircraft Establishment. Type tests have also been completed on further Ketay synchros, and C.T.A.'s are expected shortly.

Automation in Tyre Output

AT Fort Dunlop new electronic machinery, operated on a time-temperature basis, is being introduced to control the mastication of crude rubber and the subsequent mixing of the various ingredients in tyres.

To record the temperature an electric thermometer inside the mixer is used. When the required temperature is reached, an electronic switchgear unit opens the discharging door and the rubber is discharged. The machine then re-sets itself for another cycle. In the case of failure of the system, a clock will operate a master switch overriding the other auto controls.

"Beerator"

THE photograph shows output pressure variations of a "Beerator" valve manufactured by I.V. Pressure Controllers Ltd. being recorded by a Kelvin Hughes four-channel high-speed pen recorder.

The valve output is variable between 0 and 8 p.s.i. depending upon the quantity of beer required and is designed for bar or cellar installation.

Two channels are being recorded, using S. & E. Laboratories' variable inductance transducers. A comprehensive and permanent record of high-speed transient inlet and outlet pressure changes is thus obtained.

"Beerator"

Lighting at the Solartron Pilot Plant

IN the pilot plant for the manufacture of pressure transducers much of the work for the assembly of parts is done with the aid of $\times 25$ magnification binocular microscopes. An illuminating ceiling was recently installed consisting of stretched p.v.c. in frames. The diffusing effect of the p.v.c. resulted in a totally illuminating shadowless panel which appeared to reduce fluorescent light fatigue.

"Carbodrip" Price Reduction

WILD - BARFIELD ELECTRIC FURNACES LTD., of Watford, announce a reduction in price of their patented "Carbodrip" gas carburising fluid in the United Kingdom.

This reduction follows a fall in the cost of raw materials and will result in even greater savings in operating costs by users of "Carbodrip" in drip feed gas carburising furnaces.

Transistorised Level Control Equipment Price Reductions

LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LIMITED, of Rugeley, Staffordshire, announce the introduction of substantial price reductions for their T.L.C. transistorised level control equipment. The transistorised level control is now in quantity production and orders can be executed promptly. The new price for a single level installation varies between £25 and £35 and for a multi-level installation from £45 to £65 according to the type of probe used.

Computer Device to Help Railways' Electrification Plans

AN electronic analysing recorder is under development by the Computer Division of the Microcell Group.

The object of this device is to assist the British Transport Commission with the testing of its a.c. electrification works and to obtain design information for use with future a.c. electrification.

Based on the computer principle, the analysing recorder is intended to save thousands of man-hours that would be involved if the information required had to be obtained by observers watching instrument dials and noting readings on paper at regular intervals.

Instead, all the information, covering an experimental section of the track, will be automatically recorded in a form which can be assimilated later by computers, thus enabling the various phenomena to be predicted when existing railways are converted from steam and diesel traction to the overhead electrification system.

Apart from the advantageous economics in employing this method in the preparatory stages, the analysing recorder is one of the devices which the Commission will use to assist with the checking of the performance of the equipment and of the system.

If the development project meets all requirements, it is planned to have analysing recorders installed in electric trains as well as at strategic points along the test section of track.

"Isora" illuminating ceiling installed at Solartron's Farnborough factory

Digital information about the variations occurring in the electrical voltages and currents consumed by the system under varying load conditions will be permanently recorded on "Creed" punch tape.

This information will be processed by standard electronic computers in such a way that characteristic features will be automatically printed in a tabulated form for use by the designing engineers. More than seven million digits of statistical information is expected to be recorded during a two-hour test run.

One of the many interesting features of the analysing recorder is the electrical synchronous clock which automatically issues impulses in a binary coded form suitable for recordings on tape. This clock can be synchronised either to the mains or to a master oscillator of high stability.

The equipment has been designed to the requirements of Mr. S. B. Warder, Chief Electrical Engineer, British Railways Central Services.

Tour of Middle East

MR. D. F. HAYDON, chief technical sales representative of Baird & Tatlock (London) Ltd., and Hopkin & Williams Ltd., made a six-week tour in the Middle East recently. He visited agents, representatives and customers in the Persian Gulf, Iraq, Iran and the Lebanon.

Electronics in Local Government

ELEVEN local authorities and four regional hospital boards, who are ordering or considering ordering an I.C.T. Type 555 electronic calculator, have set up a study group to investigate the applications of this equipment in their office systems. The group, which has been established in conjunction with the makers of the machine, International Computers and Tabulators Ltd., is modelled on a computer study group set up last year.

The syllabus agreed at this session includes:

(i) technical appreciation of the equipment;
(ii) consideration of the problems of organisation and operation involved in the installation and use of such large-scale equipment;
(iii) case studies of existing installations in local government and in other fields;
(iv) progress reports and exchange of experience.

The group plans to meet at approximately monthly intervals—at first in London, where this equipment is available for demonstration purposes, but later in provincial centres.

New Works Department Extension for Furse, of Nottingham

THE completion of a modern three-storey building extension to their Works Department is announced by W. J. Furse & Company Ltd., of Nottingham, a member of the E.V. Industrials Group.

The new functional building, which adds 10,000 sq. ft. of floor space to the existing capacity, was constructed to accommodate the growing volume of production of this department which designs, manufactures and installs goods and passenger lifts ranging in capacity from 56 lb to three tons. The department also manufactures a range of electrical and lighting equipment which is widely used in theatres.

Vibration Test Laboratories

W. BRYAN SAVAGE LIMITED opened their Vibration Test Laboratories on 31st March, 1959.

These laboratories will be manned by experienced vibration engineers, and will have the full backing of the W. Bryan Savage main laboratory.

The object of these laboratories will be for accepting vibration/environmental work which customers are unable to carry out themselves owing to heavy commitments of their own vibration equipment, or not having the equipment available.

All enquiries should be addressed to: 17 Stratton Street, London, W.1 (Grosvenor 1926.)

Equipment available as undermentioned:—

V.1001/Type 10K system, including automatic sweep	...	3,000 lb + thrust
V.1000B systems, including ancillary equipment	...	800 lb + thrust
V.1000 system	...	600 lb + thrust
V.999 system	...	250 lb + thrust

Electronic Engineering Association—New Council and Chairman

FOLLOWING the annual general meeting of the Electronic Engineering Association and the election of its new council, Mr. L. T. Hinton, B.Sc., M.I.E.E. (Standard Telephones and Cables Limited), was elected chairman in succession to Mr. F. S. Mockford (Marconi's Wireless Telegraph Co.). Mr. R. R. C. Rankin, O.B.E. (Mullard Ltd.) was elected vice-chairman.

Advisory Council on Middle East Trade

MR. H. G. NELSON, who, as the Board of Trade announced recently, has become industrial leader and vice-chairman of the Advisory Council on Middle East Trade, is managing director of The English Electric Company. He was one of the original members of the Council when it was set up early last year.

Calculator on Nuclear Work

THE CENTRAL ELECTRICITY GENERATING BOARD has placed an order with International Computers and Tabulators Ltd. to rent an I.C.T. Type 555 electronic calculator. It will be used for stores and cost accounting, mathematical applications and nuclear fuel element calculations.

The Type 555 is the most advanced of the range of I.C.T. electronic calculators and provides limited computer facilities within conventional punched card equipment. It is, in fact, often described as a "plugged programme computer".

Its magnetic drum memory gives it a storage capacity of more than 17 times that of previous calculators. Working at 6,000 cards an hour and capable not only of addition, subtraction, multiplication and division, but also of extracting square roots, the 555 will handle large masses of calculations not readily disposable by other means.

Coventry Gauge and Tool Co. at Leipzig Fair

AT the Technical Section of the Fair the company exhibited the following machine tools:—

The "Matrix" No. 16 Two-way Tap Grinding Machine.

The "Matrix" No. 33 Thread Grinding Machine.

The "Matrix" No. 37 (Type 1) Thread Grinding Machine.

The "Matrix" No. 55 Two-way Tap Grinding Machine.

The "Matrix" No. 61 Gear Grinding Machine.

The above were accompanied by a representative selection of metrological equipment.

AMF Limited

THE name of the Industrial Machine Co. Ltd. has now been formally changed to AMF Limited with the object of securing a closer association with the Parent Company, American Machine and Foundry Company of New York.

E.M.I. Television Equipment at Leipzig Fair

A PAIR of one of the latest types of television microwave links, as used in the Eurovision network, were shown by E.M.I. Electronics Ltd. at this year's Leipzig Fair.

Microwave links of this type are now extensively used in the U.K., Europe and other parts of the world to relay television programmes where the provision of land line facilities is not practicable.

Also being shown for the first time in Eastern Europe was an E.M.I.closed-circuit television system now extensively used in industry and business for a wide variety of applications. This equipment can operate under poor lighting conditions and has been designed to withstand rough industrial use. It has a full range of remote control facilities and enables operations to be observed at any number of remote points.

Interest in closed circuit television, as in other automation aids to greater efficiency, is now increasing in Eastern Europe, and it is anticipated that there is likely to be a growing demand for this type of equipment from Eastern Germany in the future.

Another industrial electronic instrument exhibited was E.M.I.'s new ultra-high intensity precision stroboscope Type 6. This instrument, which can be applied to many industrial uses, employs a xenon discharge tube.

Displays of E.M.I.'s latest electronic machine tool systems and examples of the complicated work-pieces they can produce, were also shown.

Black Knight Rocket Fired

THE second Black Knight ballistic rocket test vehicle was successfully fired at the Australian Rocket Range at Woomera recently. Comprehensive instrumentation installed in the vehicle and on the ground for monitoring its behaviour performed satisfactorily throughout flight, yielding further valuable data. At the peak of its trajectory Black Knight reached an altitude of approximately 350 miles.

Ultra-sound Image Camera

SOUND waves which carry speech and noises through air or water are in many ways similar to light waves or rays. They can be focused with lenses, and images of objects exposed to noise can be formed and reproduced at a distance.

The wavelengths of audible sounds are too great to make these techniques useful, but for ultra-sound of frequency 1-20 millions of cycles per second the wavelengths in water or oil are only fractions of a millimetre and sound lenses 10 cm across are very efficient.

The ultra-sound "television" camera differs from an ordinary television camera in that the light-sensitive (photo-electric) image-receiving-surface is replaced by a sound-sensitive (piezo-electric) image-receiving-surface. This is simply a bare slice of crystalline quartz which under the impact of sound develops, on each point of its surface, a voltage proportional to the ultra-sound intensity. The value of this voltage is detected, point by point, by a scanning electron beam, and after amplification controls the brightness of a television receiver to produce a visible image of the invisible internal structure under examination.

I.E.A. European Conference Tour

PREVIOUS European visits have been followed up by holding conferences in six cities, primarily to meet potential exhibitors. The events attracted considerable press and hence visitor attention, especially as the chairman of the I.E.A. Committee delivered on each occasion a special goodwill message from the President of the Board of Trade.

Radioactive Isotopes: Atomic Energy Authority Reorganisation

To meet the increasing demand for radioactive isotopes and to continue to improve their service to users throughout the world, the U.K. Atomic Energy Authority announce a reorganisation of the isotopes production and marketing which has hitherto been shared between the Radiochemical Centre at Amersham and the Isotope Division of A.E.R.E. Harwell.

It has been decided to widen the scope of the Radiochemical Centre to form a single comprehensive organisation for producing and marketing all such isotopes.

The Radiochemical Centre has its headquarters and principal laboratories at Amersham and will have irradiation

facilities at Harwell and at other Authority sites.

Dr. W. P. Grove has been appointed Director of the reorganised Radiochemical Centre.

The reorganisation is already effective, but users of radioisotopes should continue, until they are advised of new arrangements, to order their requirements from Amersham or Harwell as they have done in the past.

Research into the properties of isotopes and new applications of them and their radiations will be continued by the Isotope Research Division at Harwell and at the Wantage Radiation Laboratories. This division will continue to operate the Isotope School.

Both the Radiochemical Centre and the Isotope Research Division will remain part of the Research Group of the Atomic Energy Authority.

Brilhart Factory Extension

BRILHART LTD., gauge components manufacturers, have had plans approved to erect extensions to their factory at Cuckoo Lane, Hatfield, Thorne, Yorks.

Industrial Control System Components Conference

ON 4th and 5th May, 1959, the School of Electrical Engineering of Purdue University and *Control Engineering* magazine held a conference on industrial control system components at the Memorial Centre, Purdue University. This was a working-level conference, organised to tell engineers in industry where and how to use many of the new types of control components that have recently become available.

The conference was divided into four sessions: actuators; power amplifiers; transducers; and logic elements.

Crompton Parkinson Tachogenerators: Price Reductions

THE list price of standard foot and flange-mounting pattern tachos have been reduced from £17 10s. 6d. to £14 19s. 0d.; the foot-mounting pattern with 1 : 4 step-up gearbox has been reduced from £31 12s. 2d. to £26 18s. 0d. The prices of C.P. tachometer indicators remain unchanged.

Honeywell Controls' Sales Conference

DIRECTORS and managers of the twelve European companies associated with Honeywell Controls Limited recently held a sales conference in London. The photograph shows C. B. Meech, left, a vice-president of Honeywell's U.S. associates, chatting over cocktails to D. H. Powell, centre, and V. D. MacLachlan. Mr. MacLachlan is director and general manager of Honeywell Controls Limited. Mr. Powell is sales manager of the division that supplies automatic controls for commercial buildings.

Honeywell Controls' sales conference

Elliott-Automation Subsidiary

ELLIOTT-AUTOMATION LTD. announces that it has formed a new subsidiary company, The Swartwout Company Ltd., to manufacture and sell the all-electronic control systems for the process industries, heating and ventilating and for power station instrumentation (both atomic and conventional), developed by The Swartwout Company of Cleveland, Ohio.

Elliotts entered into an agreement with the American Swartwout Company two years ago. Since then business in Swartwout systems, which are sold in America under the trade name "Autronic", has so expanded that Elliotts have found it desirable to form this new company to handle it, particularly in the export field.

Changes of Address

THE Public Relations Office of the Elliott-Automation Group has moved to:—

34 Portland Place, London, W.1.
Telephone: LANgham 9271.

The London office of Rocol Ltd is now at General Buildings, Aldwych, London, W.C.2, telephone HOLborn 1985 (two lines).

The Cambridge branch office of British Insulated Callender's Cables Limited has moved to:—

65 Devonshire Road, Cambridge.

The telephone number remains as before: Cambridge 55451/2.

New Sheffield Premises for Communication Systems Ltd.

THE Sheffield branch of Communication Systems Ltd. has moved into new premises at 27 Collegiate Crescent. The extra space available permits the maintenance department to house their vehicles on the premises, thus greatly improving service to subscribers in the area. Mr. J. L. Campbell is manager.

Pneumatics and Hydraulics for Industry, Exhibition and Convention

THIS new exhibition will be held in the Alexandra Palace from the 12th to the 16th October next. Organised by Macfarlane Watson Ltd., 36 Beauchamp Place, London, S.W.3 (Telephone: KENsington 2857 and 1364), this exhibition will include, for the first time since the closure of the British Industries Fair, facilities for outside demonstrations of equipment incorporating pneumatics and hydraulics. Points of interest include a unique shell scheme of revolutionary design and a convention running throughout the exhibition where speakers from the United Kingdom, the Continent and the U.S.A. will discuss the latest developments in pneumatics and hydraulics relating to their particular industries. A further feature of the Convention will be the inaugural meeting of The Fluid Power Association.

Chinese Scientific Literature

THE Lending Library Unit of D.S.I.R. has started to collect Chinese scientific literature. About 150 Chinese periodicals are now on regular order and the first batch has arrived at the library's London premises.

The library already organises a scheme for the translation of Russian scientific literature, in collaboration with the National Science Foundation in the United States. This may possibly be extended in the future to include scientific literature from China. Meanwhile, the contents of these Chinese publications must be assessed, and a scientist with a knowledge of Chinese is being recruited by L.L.U. to select and promote use of Chinese scientific and technological literature.

European Scientists at U.S. Instrumentation Conference

DR. C. J. D. M. VERHAGEN, of Delft, The Netherlands, is scheduled to make a keynote address broadly surveying major instrumentation developments overseas during 1959 at the annual conference and exhibit of the Instrument Society of America.

To assist the Instrument Society in further carrying out the conference and exhibit theme, "World Progress in Instrumentation", Dr. Verhagen, professor-director of Laboratorium Voor Technische Physica Der Technische Hogeseschool, is lining up other speakers.

Moreover, the ISA conference, to be held this year in Chicago, is expected to be attended by a delegation from the International Federation of Automatic Control. This is because the general assembly of I.F.A.C. world-wide organisation of instrumentation authorities will be meeting in Evanston, Illinois, near Chicago, the week before the Instrument Society event.

In addition to greater participation by overseas scientists than at previous conferences, plans made thus far for the 1959 meeting include these highlights:

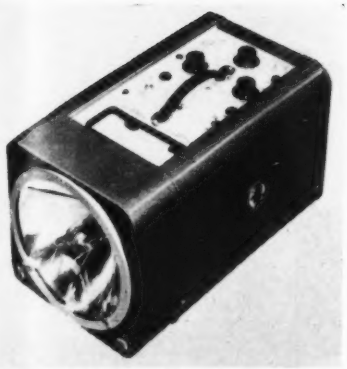
1. At least seven major programme events emphasising the use of computers for running industrial processes.
2. The equivalent of one and a half days of sessions on photo instrumentation. Nine presentations are expected to be made on the use of cameras in industrial processing.
3. Management's interest in instrumentation as a route to new levels of process efficiency will be stressed both in conference papers and new equipment displays.
4. Action to help alleviate the shortage of instrument men and other technicians, a major bottleneck to progress in instrumentation and automation will be attacked by a clinic on instrumentation fundamentals, tailored to the training needs of technicians.

Direct Viewing Storage Tubes

A COMPREHENSIVE display of their products was recently made by the English Electric Valve Co. It included television camera tubes, travelling wave tubes klystrons, klystron amplifiers, magnetrons and display storage tubes.

These last are used to examine single or repetitive transients of long duration, in daylight. The writing speed is 0·3 μsec. With special circuitry, persistence of 20 minutes can be achieved, but in general

EXPORT NEWS



E.M.I. precision stroboscope, Type 6

the persistence is of the order of 3 to 4 minutes. The applications of direct viewing storage tubes include facsimile reproduction, computer read out display, and the visual display of transients in a process control system.

E.M.I. Stroboscope at Leipzig Fair

CONSIDERABLE interest was shown at this year's Leipzig Fair in E.M.I. Electronics Ltd.'s new precision stroboscope Type 6, which has been designed for a wide range of industrial applications.

Stroboscopes are now being widely used in industry to study machinery and manufacturing processes under actual operating conditions. By 'freezing' moving parts in motion they eliminate the need for machine stops, thus saving time and money.

The Type 6 stroboscope uses an ultra-high intensity xenon discharge tube, and has a flash rate of 60,000 flashes per minute. If the stroboscope is made to flash at a sub multiple of the speed of the body under inspection, observations and speed measurements may be made at speeds greatly in excess of 60,000 r.p.m.

The instrument has a high light output. The flash colour closely approximates to daylight.

An accuracy of 1% f.s.d. can be obtained, with the facility for greatly increased accuracy by use of the "read out pulse" to operate ancillary measuring equipment having a high order of accuracy. With standard decade counters, measurements may be taken with an accuracy of 0·001% ±1 count.

Built-in facilities include a photo-electric probe, photo head amplifier and a light diffuser for work in silhouette.

English Electric Deuce Computer at Liverpool University

THE UNIVERSITY OF LIVERPOOL has ordered the English Electric electronic digital computer, Deuce, and the machine, a Mark I, is being installed at the University's Ashton Hall Mathematical Laboratories. The Liverpool Deuce will be operational in the early summer and will enable the laboratories to expand very considerably the services they offer both to university departments, such as the nuclear physics and oceanographic department, and to outside organisations. Free time on the computer will also be offered as it becomes available to local industry on a time-hire basis.

Ferranti Summation Metering Equipment for Kariba

FOR the Kariba Hydro-Electric Scheme, Ferranti Ltd. have received an order worth approximately £47,000 for summation metering equipment, comprising precision grade integrating meters, electro-mechanical summators, printometer demand recorders and suites of metering cubicles.

These equipments will be used to meter six 100 MW generator sets at Kariba Power Station and also the supplies to the transforming stations at Kitwe, Norton, Salisbury, Lusaka, Sherwood and Bulawayo.

A two-element double disc type meter will be used throughout the scheme and it will be fitted with an outgoing 2-way impulsing contactor for the operation of electro-mechanical summators. The summators, in turn, will operate Ferranti printometer demand recorders by impulses and they will also be arranged to provide impulses for telemetering purposes.

Provision will be made for the measurement of import and export flow of both kWh and kVARh, and for the wattful component, separate summators and printometers will be used. The leading and lagging reactive power flow, however, will be measured on a new development, the Ferranti bi-directional summator. This device is capable of differentiating between leading and lagging reactive power flow for telemetering purposes.

English Clocks for Rhodesia

ENGLISH CLOCK SYSTEMS, a branch of the clock and watch division of S. Smith and Sons (England), has received a contract for time recording equipment for the Rhodesia Railways.

E.M.I. Plans Latin American Export Drive

MR. R. A. SEAL, of E.M.I. Electronics Ltd.'s Export Department, has recently completed a 25,000 mile business tour of Central and South America. He spent three months meeting E.M.I.'s agents and prospective customers in Cuba, Venezuela, Brazil, Argentina, Uruguay, Peru and Ecuador.

Everywhere he went, Mr. Seal was impressed by the interest shown in British electronic equipment, and in the recent advances made by E.M.I.

British companies wishing to trade in Latin America should design equipment to operate under extreme conditions of temperature, humidity and altitude. It is not good enough to send equipment built to specifications which are suitable for use at home.

E.M.I. is now planning an intensive drive in Latin American countries to boost its exports of specialised equipment such as radio and television stations, instruments and computers.

Elliott Automation Limited

THE Industrial Weighing Division recently despatched four complete electrical weighing systems to the Indian Iron and Steel Co. Ltd., Calcutta, for weighing and printing out the weight together with the code number of hot billets, after their passage through the cogging mills. Each equipment consisted of four sets of load cells and the associated digital and print-out equipment. The value of the order was £4,000.

Load cells are being sold in some quantity to the Streeter-Amet Company, U.S.A. Even with import duties, shipping and tariff costs added, the prices are only approximately one third of the cost of the American equivalent.

Batteries for New Indian Steelworks

LARGE orders for battery equipment have been received by NIFE Batteries Ltd. at Redditch for the £100 million steelworks which is being constructed at Durgapur in the Damodar Valley, West Bengal.

The battery equipment ordered from NIFE Batteries, the total cost of which amounts to about £30,000, will be used for switchgear duties and emergency lighting. The equipment has been specially designed for use in the tropics and all the batteries supplied will be for 110 volts, which has been adopted as standard throughout the works for tripping and closing supplies.

British Teleprinters for Holland

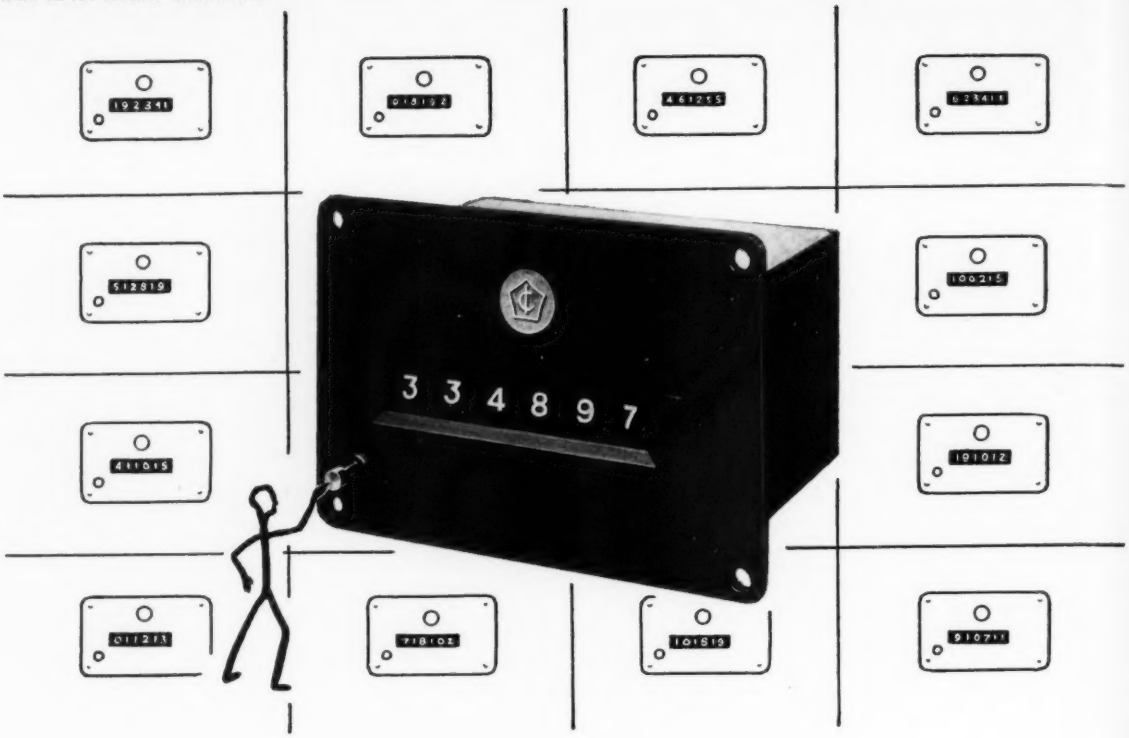
CREED & COMPANY LIMITED announce that delivery of 60 of their new Model Seventy-five Teleprinters has been made recently to the Royal Netherlands Navy.

These machines will be installed in ships of the Netherlands Navy. For such service the ability to operate in non-level positions is naturally of paramount importance, and the superiority of the British machine over its competitors in this respect was a factor in securing this export order.

The Model Seventy-five Teleprinter is capable of sending and receiving printed messages in page form over wire or radio circuits at a speed of 100 words per minute, a 50% advance over the present international standard. It will also operate at 60 words per minute (standard U.S.A. speed), and at 66 words per minute (European and International speed), a simple gear change being all that is required to alter speeds.

A feature of the machines being supplied to the Netherlands Navy is the incorporation of suitable circuitry enabling them to be used over land-line or radio circuits simply by throwing a switch. Thus, whilst the machines will be operated over radio circuits when at sea, they can also be used without modification when the ship in which they are installed is in port and connected to dock-side land-line telegraph circuits.

Circle 52 for further information



a ℂ NEW

HIGH-SPEED PANEL MOUNTING ELECTRO-MAGNETIC COUNTER

with PUSH-BUTTON RESET

All the well-tried features of our Type 100 Series Electric Counters are incorporated in this new model

plus—Sealing against dust.
plus—Large easily-read figures.
plus—Even longer life expectations at 25 counts per second.
plus—First wheel graduated 0 to 11 as optional standard.

Write for full details.

Counting Instruments Ltd

A similar counter with electric reset is also available. Details on request.

COUNTING INSTRUMENTS LTD., 5 Elstree Way, Boreham Wood, Herts.
Tel.: ELStree 1382 (4 lines)

Export Orders for E.M.I. Electronic Enlarger

SINCE its recent introduction E.M.I.'s new electronic enlarger has already proved popular with progressive printing, photographic, research and medical organisations in this country and overseas.

Orders have included one from the U.K. Atomic Energy Authority at Harwell, and others from South Wales, Denmark and South Africa. Inquiries have been received from many parts of Europe, South America, India and as far afield as Japan.

40 Million Electron-Volt Linear Accelerator for Deutsches Elektronen-Synchrotron (D.E.S.Y.), Hamburg

METROPOLITAN-VICKERS ELECTRICAL CO. LTD. has secured an order for a 40 million electron-volt electron linear accelerator from the city of Hamburg for Deutsches Elektronen-Synchrotron (D.E.S.Y.), Research Group, Hamburg. The value of this order is approximately £250,000.

The accelerator will be used to inject a beam of 40 MeV electrons into a large electron synchrotron which will then further accelerate the electrons to an energy of 6,000 MeV.

The equipment has an overall length of approximately 35 ft, and comprises five sections of accelerating waveguide, each 1¼ metres long, together with an electron gun and pre-buncher at the injector end. Each accelerator section will be fed by a high power klystron, also manufactured by Metropolitan-Vickers. In addition, a considerable amount of associated equipment, including the klystron power supply together with controls and other services, is included in the contract.

Marconi Instruments Limited

MARCONI INSTRUMENTS LTD. are providing valve voltmeters, signal generators, oscilloscopes and frequency measuring apparatus to the total value of approximately £5,000 to the new Calibration Centre in Delhi.

Czechoslovakia

KELVIN & HUGHES (INDUSTRIAL) LTD. announce that an order for automatic ultrasonic inspection equipment to the value of £10,000 has been placed by KOVO, the Czech buying organisation. The equipment will facilitate the rapid scanning of rolled mild steel bars for internal defect. Bars of up to 7·9 in. in diameter and moving at a speed of 98·5 ft per minute are marked and automatically rejected if they contain defects in excess of a pre-determined degree.

Ferranti Computer Exports Now Nearly £2,000,000

A FERRANTI high-speed Mercury electronic digital computer, valued at about £150,000 has been sold to the University of Buenos Aires, Argentina.

The machine will be engaged in nuclear research work, although the University will also make the machine available to commercial and industrial firms.

Ferranti Ltd. also market the large Perseus data processing system and the Pegasus all-purpose system. Sales of these abroad, together with the six Mercury computers exported and the earlier Manchester models bring up the total exports of Ferranti computers to 13, valued at about £2 million.

Marconi Test Equipment Abroad

As part of their intensive sales promotion campaign for 1959, Marconi Instruments Ltd. showed telecommunication measurement equipment at three overseas exhibitions in March.

These were the Institute of Radio Engineers Convention in New York, the Leipzig Spring Fair and a private demonstration of instruments in Budapest.

Hungary Buys British Instruments

HUNGARY has placed an order for hydraulic dynamometers with Messrs. Heenan and Froude Ltd., Worcester. The initial order is understood to be worth about £23,000.

This is the first time Hungary has done business with a British firm for this type of instrument, which has formerly been obtained from Western Germany.

Microwave Network

A CONTRACT for a microwave network in Europe, worth approximately £750,000, has been placed with Standard Telephones and Cables by the Royal Board of Swedish Telecommunications.

The network will be used for the transmission of telephone and television signals.

Wayne Kerr Export Drive

WAYNE KERR announce they are exhibiting, at the New York Radio Engineering Show, a full range of their measuring instruments and resin components and transformers. Mr. Barry Rogel, chief planning engineer, will be present to assist the President of the Wayne Kerr American Company. He will also give three lectures.

At Lisbon, where the British Trade Fair will be held from 29th May - 14th June, the following instruments will be displayed and demonstrated

Vibration meter B. 731A.
Electronic micrometer B. 721.
Universal bridge B. 221.
Component bridge B. 521.
Electronic thermometer LT. 100.

$2,000,000 Order for Seat Reservation System

AN order for electronic equipment worth $2 million which is claimed will provide the fastest and most modern seat reservation system in the world has been announced by Ferranti-Packard Electric Limited, the wholly-owned Canadian subsidiary of Ferranti Ltd.

The order covers booking office and communication equipment which is used in conjunction with a central computer. The system comprises equipment which sends information to and receives answers from a central computer. For this purpose, a device known as a Transactor is used, which will be located in every Trans-Canada Air Lines booking office across Canada. In the larger offices, up to fifty Transactors or more may be installed.

The Transactor, and its techniques, is the vital new part of this system but it has many other applications such as the administration involved in retail stores, mail order firms, stock and stores control and other similar businesses where information is derived at many places, some distant from the central office.

In operation, a pencil marked card is inserted in the Transactor by a T.C.A. clerk requesting a reservation on a certain flight. The central computer determines whether or not space is available on the flight in question and the information comes back to the Transactor causing it to punch a hole in the edge of the card providing the answer to the reservation request. When inserting a card in the Transactor the information required is obtained practically instantaneously and red and green lights on the Transactor indicate whether the computer is engaged or free for use.

Russian Orders for Mather & Platt

MATHER AND PLATT is hoping to book Russian orders worth £3 million to £4 million over the next few years.

The company has received an order through Rustyfa Ltd.—the consortium building the £15 million tyre plant at Dniepropetrovsk—for pumps and electrical motors. Mather and Platt is one of the companies in the consortium.

Another order for two sardine canning lines—worth about £220,000 is in an advanced state of negotiations.

Proportions of Kew Manometers

The ratio of the areas of bowl and tube of a Kew manometer is often made 99 : 1, 49 : 1 or 24 : 1 to give a scale with a contraction of 1%, 2% or 4%. This makes the scale spacing easy to calculate, though awkward lengths are still met in dividing the scale. If the easy calculation is given up, a pressure scale in pounds per square inch can be got with a common inch rule, by adjusting the contraction suitably.

A column of mercury 2·0360 inches high at 0°C exerts a pressure of 1 p.s.i. The scales of standard barometers are now divided to read correctly when the whole barometer is at 0°C, but workshop manometers are more conveniently used if they read correctly at room temperature. Converting the figure above gives 2·0434 inches of mercury at 20°C equals 1 p.s.i. Now if the areas of tube and bowl are chosen so that the mercury rises two inches in the tube while it falls 0·0434 in. in the bowl, an inch rule applied to the tube need only be renumbered to read in pounds per square inch. The ratio of areas required is $[(2{\cdot}0434/2)-1]=0{\cdot}02170$ or 46·08 to 1.

As a force of one pound is defined as 32·1740 poundals and not as the local weight of a mass of one pound, correction for gravity may be needed. The figure 2·0434 above should be multiplied by $32{\cdot}1740/g'$, where g' is the local value of the accleration of gravity, found either by measurement or from tables of gravity and latitude. The result is then used as above to find the ratio of areas required.

Of course scales of inches of mercury, millibars, height and airspeed must still be specially calculated and cut.

PERSONALITIES

Mr. E. M. Lee

Mr. J. H. Barry

Mr. J. H. Barry has joined Livingston Laboratories Ltd. as Northern Field Engineer. Mr. Barry may be reached through the company's laboratories at Retcar Street, London, N.19, or directly at his home, 5 Princess Drive, Knaresborough, Yorkshire.

Mr. D. D. Arnold, who has been with the company for many years, is taking over as Southern Field Engineer.

Mr. F. R. G. Webb

Livingston Laboratories Ltd. announce the appointment of Mr. F. R. G. Webb as manager of Laboratory Services. Mr.Webb was for many years manager of the Test Gear Department of the Plessey Company.

At the same time, the company announces that Mr. S. W. Urry becomes manager of Field Engineering Services and Mr H. Sellers manager of Commercial Services.

Mr. E. G. Wakeling

Mr. E. G. Wakeling has joined Advance Components Ltd. as general manager. Mr. Wakeling, prior to this appointment, was manager of the Servo Division of Elliott Brothers Ltd.

Changes at British Resin Products

Mr. J. D. Winston has been appointed general sales manager, British Resin Products Limited and is now responsible for the sales of all the plastics materials produced or marketed by B.R.P. Mr. G. E. H. Smock, who was previously assistant sales manager in charge of Rigidex Polyethylene, has been made sales manager for this material.

As a result of the appointment of Mr. S. R. Badley as market development manager for the Distillers Plastics Group, Mr. C. D. Harvey-Piper has been made sales manager in charge of B.R.P. adhesive and binder resins. Mr. R. Hayes has been appointed as technical service manager for Rigidex Polyethylene, while Mr. J. D. Davies takes over as technical service manager for Cellomold, Rockite and Styron.

British Geon Appointments

British Geon Limited announce that Mr. R. J. Facer has been appointed general sales manager. Mr. J. E. Richardson takes over as export manager from Mr. S. A. Williams who becomes administration manager (Sales). Mr. G. Y. Blomeley has been appointed Northern manager.

Mr. P. W. Underhill

The West Midlands Branch of the Institute of Export has appointed a new chairman, Mr. P. W. Underhill, who is chief shipping officer at Birlec Limited.

Mr. Underhill joined the branch in 1939 and was elected to the local committee in 1950. Two years later he was elected chairman of the branch's programme and social sub-committee and later became vice-chairman of the branch. Mr. Underhill was appointed a member of the National Council of the Institute in 1953.

He has been with Birlec Limited for twenty-seven years and became chief shipping officer in 1950.

Mr. Underhill's private address is 9 Robin Road, Erdington, Birmingham, 23. Telephone Erdington 7044.

Belling and Lee Export Managers

Mr. D. W. Rippin, M.I.R.E., export manager of Belling & Lee Limited, is resigning his position with the company to emigrate to Canada where he will be engaged in a senior sales capacity in the electronics industry with the Astral Electric Company Limited, of Toronto, who are the Belling & Lee Limited Canadian agents.

Mr. J. E. Bailey, B.Sc. (Elec. Eng.), A.M.Inst.E., who has been a technical representative for Belling & Lee Limited for two years, has been appointed export manager. Before joining Belling & Lee Limited, Mr. Bailey was with Decca Radar Limited and Marconi's Wireless Telegraph Company Limited.

Mr. E. M. Lee

Mr. E. M. Lee, B.Sc., M.I.E.E., M.Brit.I.R.E., Fellow of the Television Society, is the new president of the Radio and Electronic Component Manufacturers' Federation following the retirement of Major Peter.

Mr. Lee, managing director of Belling & Lee Limited since its foundation in 1922, and a director of Insulators Limited (Plastics), was one of the founder members of the original R.C.M.F., and has been chairman of the Council on two occasions. He was elected a life vice-president many years ago. During the war, Mr. Lee was chairman of the Joint Industries and Services Technical Components Committee.

Mr. P. Furse

Furse Wholesale Ltd., of Nottingham, announce the appointment of Mr. Peter M. Furse, M.A., A.C.A., as joint managing director. Mr. Furse, who is 32, joined the company in 1952, and was appointed a director in 1955.

Plessey Nucleonics Reorganisation

Mr. G. V. Hough, M.A., previously commercial manager of Plessey Nucleonics Limited, has become advanced projects manager, and will also take a special interest in the export activities of the company. Mr. J. S. Crick, A.M.I.Mech.E., A.F.R.Aero.S., formerly with the British Oxygen Company Limited, joins the company as sales manager. Mr. B. Daniel, G.I.Mech.E., a sales liaison engineer with Plessey Nucleonics, is joined by Mr. R. G. Jolliffe, A.M.I.E.E., from Hayward Tyler Limited, and Mr. A. Trott, A.Inst.P., from the Associated Electrical Industries Limited Research Laboratories.

Mr. W. J. Robinson

Mr. W. J. Robinson, B.Sc.(Eng.), M.I.Mech.E., has been appointed to the post of chief engineer of The British Pitometer Company Ltd. Mr. Robinson was formerly of Fluids Mechanics Division, M.E.R.L. and the Rocket Propulsion Establishment, Westcott.

Marconi Instruments' Engineer's 20,000 Miles Tour

Mr. J. H. Buying, Marconi Instruments' technical sales engineer for Africa, left London on 18th March for a three-month sales promotion tour of the African continent. Covering more than 20,000 miles, Mr. Buying's itinerary includes Entebbe, Kampala, Nairobi, Bulawayo, Livingstone and Johannesburg. He will spend six weeks in the Union of South Africa, remaining some days in all the major centres of industry.

During the latter part of his tour, Mr. Buying will visit the Belgian Congo, Nigeria and Ghana. Whilst in Ghana, he will hold discussions with the police and

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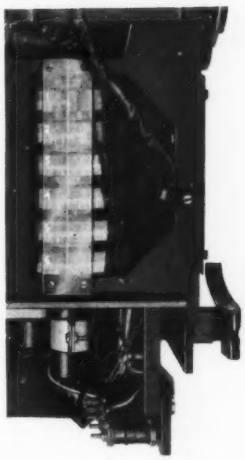

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Mr. J. H. Buying

Mr. L. Malec

Mr. D. L. Brown

Mr. T. H. Halstead

broadcasting services on the telecommunications test instruments being provided by the company in connection with the Queen's visit later this year. Whilst telecommunication measurement equipment forms the major part of the company's business in Africa, Mr. Buying will also be seeking further business for Marconi X-ray units and industrial electronic instruments.

Mr. Laurence Malec

Recently, Mr. Laurence Malec, M.B.E., A.R.Ae.S., joined the Solartron Electronic Group Ltd. as managing director of Solartron Radar Simulators Ltd., which company is responsible for the marketing, building and development of radar simulator systems, which have been and are being supplied to several European Governments, through NATO.

Mr. L. Malec is an Associate Member of the Royal Aeronautical Society, a member of the Institute of Navigation, a member of the British Institute of Management, and a Liveryman of the Guild of Air Force Pilots and Navigators.

Appointment to Smiths Aviation Division

Mr. Donald Lambert Brown, 53, M.I.Mech.E., A.M.I.C.E., M.I.Gas.E., A.F.R.Ae.S., has been appointed deputy manager of Smiths Aviation Division's Research Department at Cheltenham. He joins the Division from the School of Gas Turbine Technology, Farnborough, where he was principal.

Mr. Brown is a Freeman of the City of London, a member of the Guild of Air Pilots and Air Navigators and was, from 1956 to 1958, chairman of the southern branch of the Institution of Mechanical Engineers and a member of the Council.

BIMCAM Elections

At the Annual General Meeting of the British Industrial Measuring and Control Apparatus Manufacturers' Association, held on 3rd March, 1959, Mr. W. G. Thomas (Bailey Meters and Controls Ltd.) was elected as president of the Association and Mr. V. D. MacLachlan (Honeywell Controls Ltd.) was elected chairman.

Mr. T. H. Halstead

Mr. T. H. Halstead has become manager of the London Branch office of Honeywell Controls Limited, responsible for sales in the London area and the southern part of England. Mr. Halstead has been connected with the instrument and control industry since he first qualified as an electrical engineer in 1939.

Mr D. Richards, until recently manager of the Birmingham office, succeeds Mr. Halstead as sales manager of the Heating Controls Division. Mr. W. R. Owen takes over the Birmingham office. Mr. Owen had been responsible for the development of branch offices in Leeds, Middlesbrough, and Sheffield. Mr. G. Fox becomes manager of the Leeds office.

English Glass Co. Ltd. Appointments

Mr. R. W. Holmes and Mr. T. J. Lawson have been appointed on to the Board of Directors of the English Glass Co.

Mr. Holmes, a chartered secretary, remains as secretary of the company, a post which he has held for the last five years.

Mr. Lawson is a mechanical engineer and is in charge of the development side of the company.

New Appointments at B.T.L.

Mr. R. D. Baird, B.A., E.R.D., has been appointed a director of Baird & Tatlock (London) Ltd., and of Hopkin & Williams Ltd.

Mr. R. T. Beasley has joined the B.T.L. Group of Companies as personnel manager. He has eight years' previous experience in personnel management, with Mobil Oil Company (Coryton Refinery) and, before that, with the Watford Division of the Eastern Gas Board.

John Thompson Instrument Company Appointments

Mr. R. A. Senior has been appointed director and manager of John Thompson Instrument Company, of Wolverhampton.

He joined the company twelve months ago to fill the newly created post of sales manager and since then the company has doubled its manufacturing range and has entered the temperature control field of instrumentation. For a number of years Mr. Senior was Midlands area manager for Messrs. Kelvin and Hughes, of London.

He is a member of the Society of Instrument Technology and of the Sales Managers' Association.

A second appointment identified with the expansion of the John Thompson Instrument Company is the moving of Mr. C. S. Gilbert from Wolverhampton to Manchester, from where he will service the North of England as sales engineer. At Sunlight House, Quay Street, Manchester, Mr. Gilbert will be available to advise on all aspects of instrumentation and automatic control.

Before joining his present company, Mr. Gilbert was with Process Control Gear Limited, of St. Albans.

Managing Director's Business Tour

Mr. W. A. Hartop, managing director of George Kent Limited, went recently on an extensive ten-weeks' business tour covering much of South Africa and the Federation of Rhodesia and Nyasaland.

His itinerary for this visit was designed not only to further Export Sales' interests but also to strengthen by personal contact and discussion the close relationship which has always existed between the parent company and the many friends and business interests of George Kent (S.A.) (Pty.) Ltd., of Johannesburg, and also of the Kent Branch in Salisbury, S. Rhodesia.

British Scientific Attaché Post in Moscow—Mr. D. A. Senior Appointed

Mr. D. A. Senior, M.A., A.M.I.E.E., has been appointed to the newly created post of Scientific Attaché to the British Embassy in Moscow. He will advise the British Ambassador (Sir Patrick Reilly) on scientific matters and report on Soviet scientific and technical development in the civil field.

Mr. Senior, who is 35, will hold the rank of Senior Principal Scientific Officer and will be on the staff of the Department of Scientific and Industrial Research.

He has left the United Kingdom for a preliminary visit to Moscow and will then spend some time briefing himself in relation to all aspects of civil science in this country and improving his knowledge of Russian.

Mr. Senior joins the D.S.I.R. from the Royal Naval Scientific Service. Since 1950 he has been at the Admiralty Research Laboratory, Teddington, mainly investigating problems of instrumentation and combustion. Recently, he carried out a study of acoustic methods of fish-finding. The results of much of his work have been published in several journals.

Mr. M. Bingham

Mr. Michael Bingham, a senior director of the Microcell Group, died at his home on 3rd April. He had been in indifferent health for some time.

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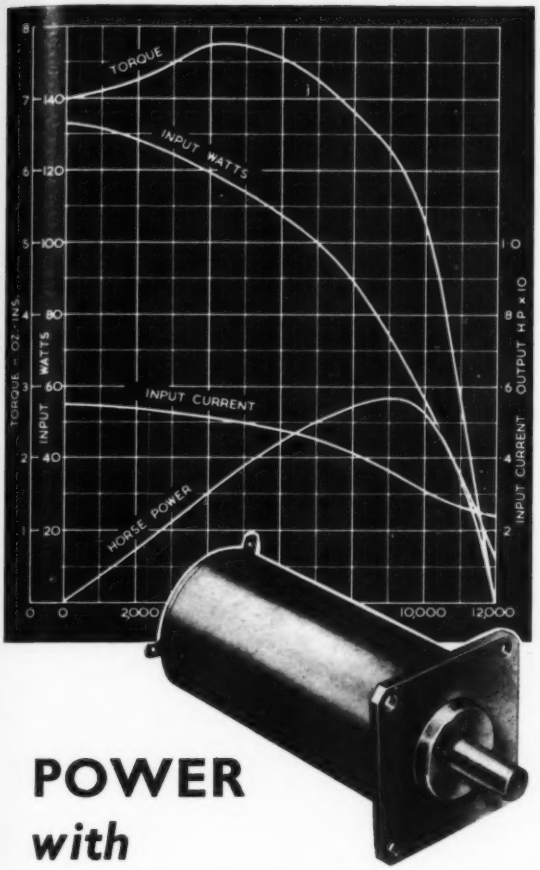

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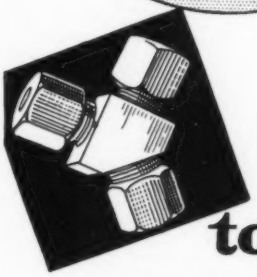

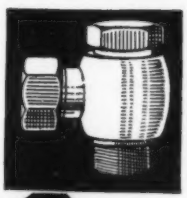

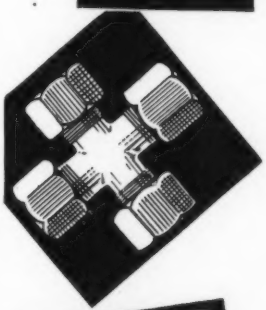

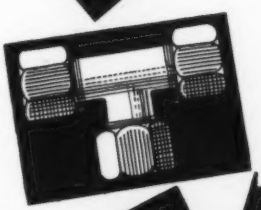

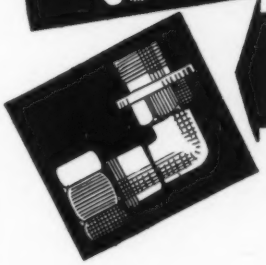

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South Yorkshire Section

THE fifth meeting of the Section, during the present lecture season, was held at The University, Sheffield, on Wednesday, the 4th February. The speaker was Mr. H. Kemhadjian, of the Mullard Semiconductor Application Laboratories. Mr. Kemhadjian presented a most interesting lecture on "The Future of Solid State Electronics in Instruments" and the good attendance showed the interest of the members in this subject.

At the outset, Mr. Kemhadjian stressed the wide scope of the subject and indicated that it would be impossible to deal with all aspects in the time available. For this reason he asked the audience if they would bear with him if he covered only the principles of semi-conductor devices, their equivalent circuitry and some of the applications of transistors and other semi-conductors.

After his introductory remarks, Mr. Kemhadjian listed the main subdivisions into which semi-conductors fall as follows:—

Diodes; transistors; light, temperature and voltage dependent devices; and hole generators; of which the transistor is the most important.

Mr. Kemhadjian then proceeded to describe the basic physics behind the operation of all these devices, beginning with the materials from which they are constructed, germanium and silicon. Both of these elements possess a very high resistance when pure and the semiconductor device depends for its operation on the presence of a very small amount of an impurity such as indium, antimony, aluminium or arsenic.

Some of these alloys are rich in electrons while others are deficient. The former material, therefore, contains free negative carriers while the latter appear to contain free positive carriers known as holes. The electron rich alloys are known as n-type material, while the electron deficient material is known as p-type. When thin slabs of each of these two types of material are fused together, normal random electron drift occurs across the interface but electrons entering the p-type material are trapped and an equilibrium state finally results in which the n-type material is left with a net positive charge and the p-type material, a net negative charge. This is the principle of the alloy junction diode and Mr. Kemhadjian ably demonstrated with the aid of slides and diagrams the charge distribution with and without the imposition of an externally applied field.

From this basic diode model it was then an easy transition to the working of the transistor which consists of a slab of n-type material, the base sandwiched between slabs of p-type material, the collector and emitter. With this construction it is possible to obtain a device with a low input resistance but which possesses a frequency limitation because the frequency cut-off increases as the inverse of the base thickness.

Despite a rather formidable electrical equivalent circuit, Mr. Kemhadjian then demonstrated that the methods of using the transistor in grounded base and grounded emitter modes are relatively simple to understand and he went on to describe the circuitry of a.f., r.f., power and d.c. amplifiers, using transistors, together with methods of overcoming the effects of temperature drift in such apparatus.

The use of photo-transistors in Eccles Jordan circuits was also described, together with the production of high voltages from batteries by means of transistor convertors.

Mr. Kemhadjian then went on to describe other semi-conductor devices such as the Zener diode, point-contact high-frequency rectifier, silicon power rectifier and photo-cells. The latter are usually of lead sulphide, lead selenate cadmium sulphide or indium antimonide and he described the particular applications for which each type was most suited.

The lecturer ended his discourse by outlining methods by which temperature measurements could be carried out using these devices and a lively discussion followed.

In the unavoidable absence of the chairman, Mr. W. R. Owen, Mr. M. Thomas, the vice-chairman, thanked the speaker, on behalf of the Section, and the response of the audience must have left Mr. Kemhadjian in no doubt as to the appreciation of his lecture.

A talk on "The Camera as an Instrument" was given on 4th March by Mr. J. A. D. Foster. The main topic was high-speed cameras in various forms, but before exploring this aspect the development of photographic film and the development of standardisation procedure was discussed in some detail. The H and D Scheiner and D.I.N. systems of film speed evaluation were compared with the modern B.S. and A.S.A. standards. The earlier methods were prone to unreliability of comparison through uncertainty of extrapolation of the density/log exposure curves which were themselves variable with different development techniques. The Lloyd Jones experiments in the United States of America, from which the A.S.A. standard was developed, took into account the fact that prints were likely to be obtained from the negatives, and allowed for factors not previously considered such as lens flare in establishing the tone range.

The speed and resolution of the film used was most important in relation to high-speed photography and a compromise choice was usually necessary because the highest resolution was not available with the greatest speed. Typical cine film had a resolution of 40-60 lines per mm so that the detail required in a frame might determine the size of film to be used. The respective areas of 35 mm, 16 mm and 8 mm cine frames were 400 sq. mm, 75 sq. mm and 16·8 sq. mm and the relative frames per foot, 16, 40 and 80. The smallest size frame would then be a reasonable choice where only the speed of the event was important or the largest where most detail was required.

The film strength limited the speed of the normal claw mechanism cine camera to about 200-300 frames per second but a rotating glass prism and a continuous film drive permitted speeds up to 8,000 frames per second on 16 mm film or 16,000 on 8 mm film.

For some purposes these speeds were still inadequate and a system devised by Courtney Pratt made use of a scanning disc and lenticule to develop speeds up to 60,000 frames per second, this in turn being further developed so that now a Russian variation claimed the apparently fantastic speed of 30 million frames per second for use on self luminous events.

The discussion after the lecture centred on the types of usage of the various forms of high-speed camera.

Surface Coating Resin Index

A new "Surface Coating Resin Index" has been prepared jointly by the Surface Coating Resin Section of the British Plastics Federation and the Surface Coating Synthetic Resin Manufacturers' Association.

The booklet, which replaces a similar index published in 1955, aims at giving under one cover, the basic information on all British-made surface coating synthetic resins at present available to the paint, printing ink and allied trades.

It is hoped to keep the index up to date by issuing supplementary information from time to time, or producing new editions.

The index is available on application to the British Plastics Federation, 47-48 Piccadilly, W.1, or the Surface Coating Synthetic Resin Manufacturers' Association, 79-80 High Holborn, W.C.1, price 5s. 0d., post free.

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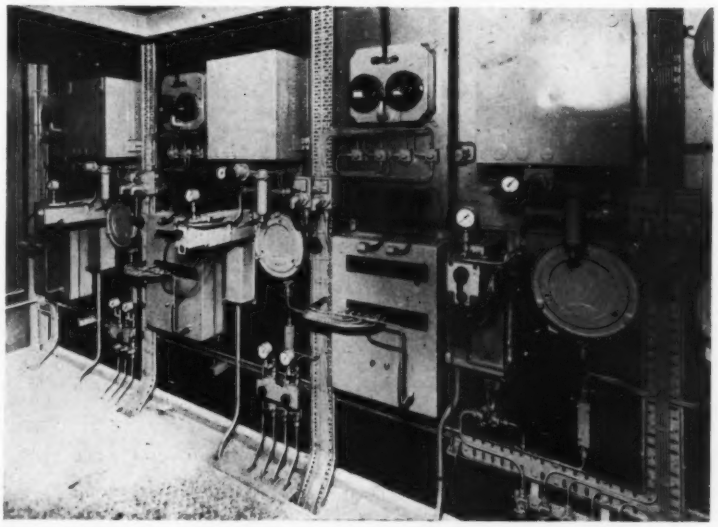

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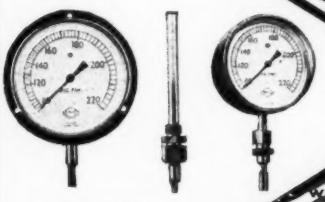

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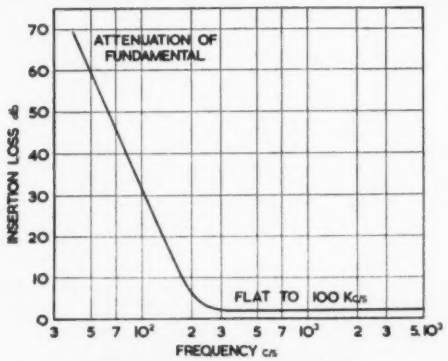

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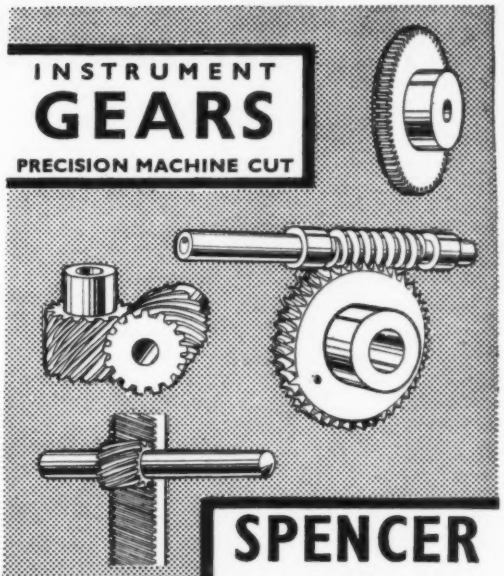

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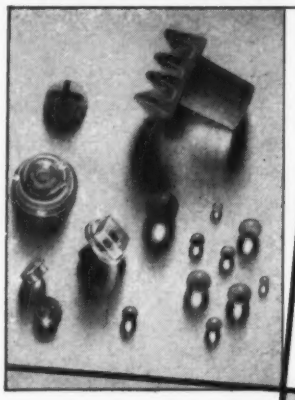

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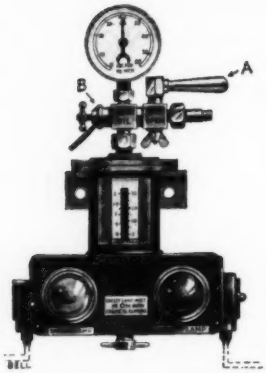

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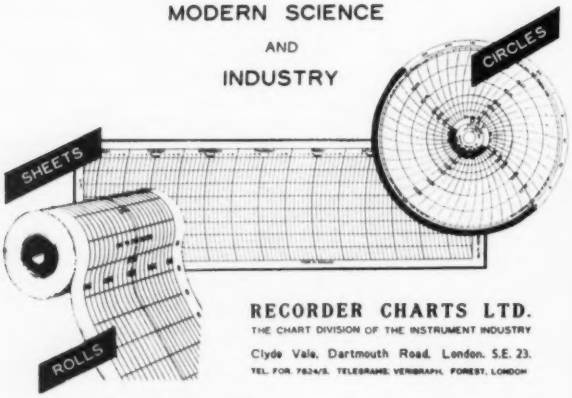

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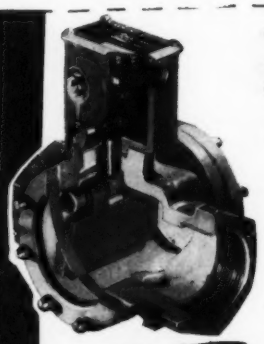

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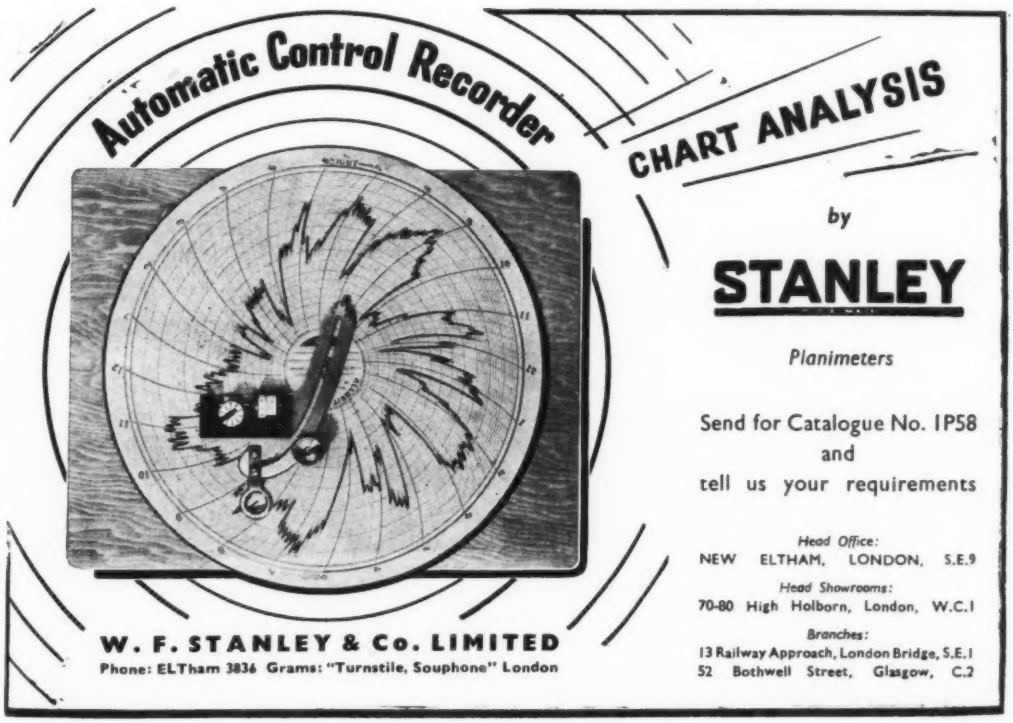

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